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Yoshikawa et al.

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(54) **POD AND METHOD OF CLEANING IT**

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(22) Filed: **Mar. 9, 1999**

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.⁷** **B08B 3/02**

(52) **U.S. Cl.** **134/62; 134/104.1; 134/902; 134/166 R**

(58) **Field of Search** 134/62, 68, 76, 134/105, 166 R, 169 R, 182, 902, 104.1

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 5,238,503 * 8/1993 Phenix et al. 134/167 R
- 5,301,700 * 4/1994 Kamikawa et al. .
- 5,363,867 * 11/1994 Kawano et al. .
- 5,445,171 * 8/1995 Ohmori et al. 134/902
- 5,470,392 * 11/1995 Yamada et al. 134/2
- 5,482,068 * 1/1996 Kithahara et al. .

- 5,603,777 * 2/1997 Ohshi 134/140
- 5,621,982 * 4/1997 Yamashita et al. .
- 5,711,821 * 1/1998 Turner et al. .
- 5,715,851 * 2/1998 Jung et al. .
- 5,746,008 * 5/1998 Yamashita et al. .
- 5,766,061 * 6/1998 Bowers .
- 6,017,397 * 1/2000 Doran .
- 6,039,057 * 3/2000 Doran .
- 6,096,100 * 8/2000 Guldi .

FOREIGN PATENT DOCUMENTS

64-12534 * 1/1989 (JP) .

* cited by examiner

Primary Examiner—Frankie L. Stinson

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(57) **ABSTRACT**

A pod for storing and carrying substrates consists of a pod body and a cover. An inlet and an outlet are formed on one of the pod body and cover. The cover is tightly fitted to the pod body to close the inside of the pod body. A washing liquid is introduced into the pod through the inlet and is discharged from the pod through the outlet, thereby easily washing the inside of the pod with the pod itself serving as a washing tank. A washing cover has an inlet, an outlet, and a heater. The washing cover is attached to the pod body when washing the inside of the pod body. Further provided is a cleaning apparatus having pipes and a pump that are connected to the washing cover. The cleaning apparatus may have a table serving as the washing cover. The table is connected to pipes and a pump.

12 Claims, 26 Drawing Sheets

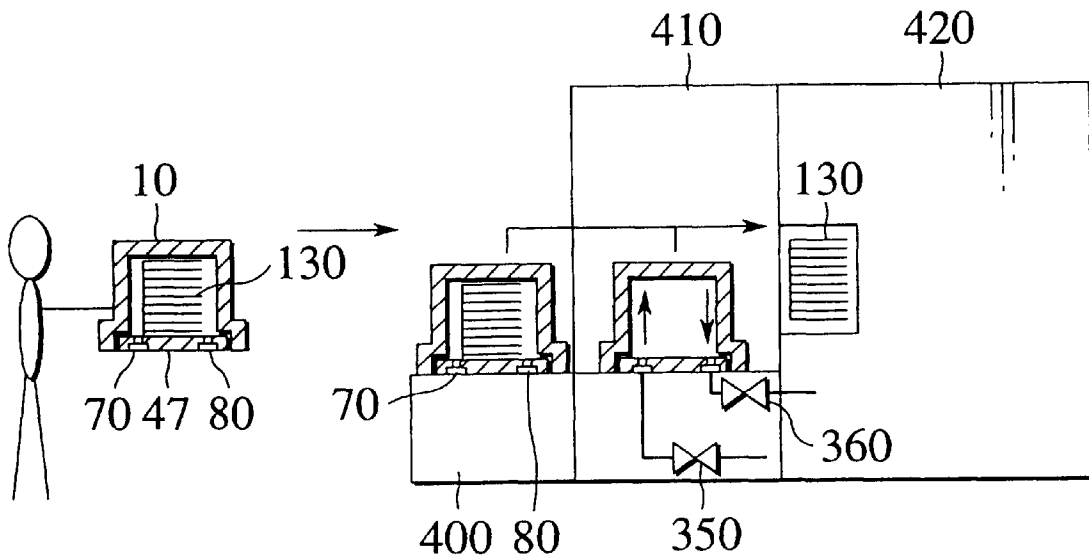


FIG.1A

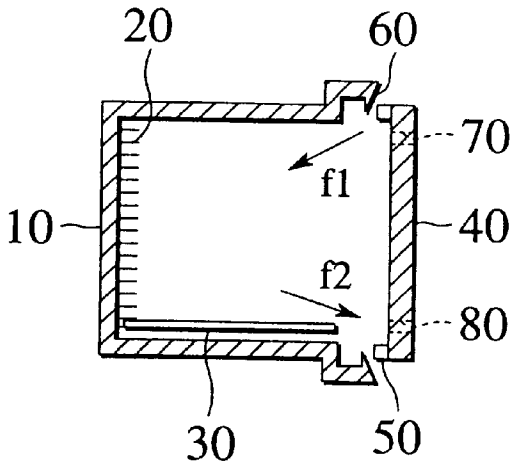


FIG.1B

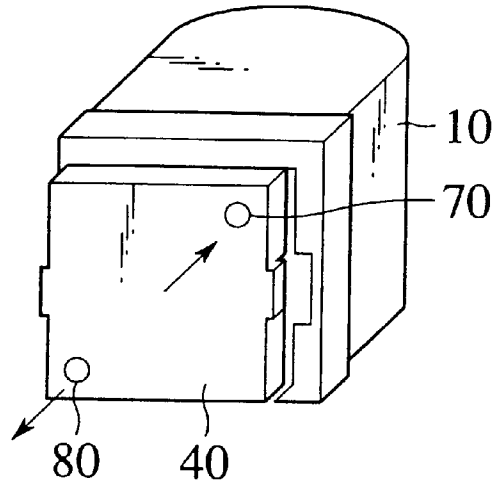


FIG.1C

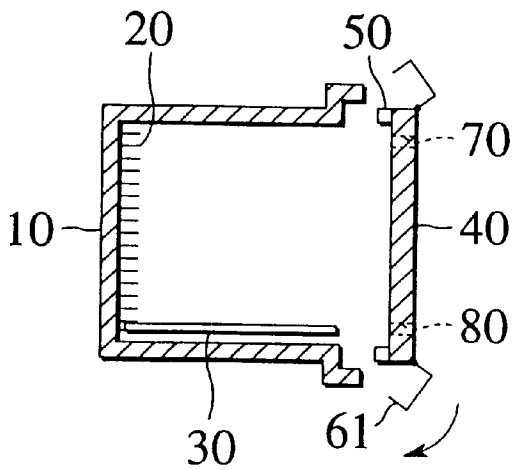


FIG.1D

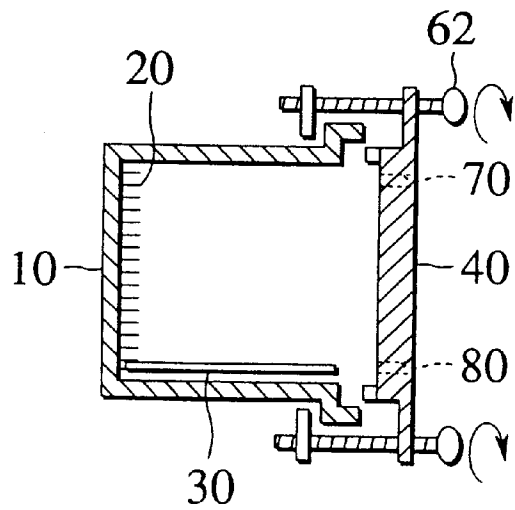


FIG.2A

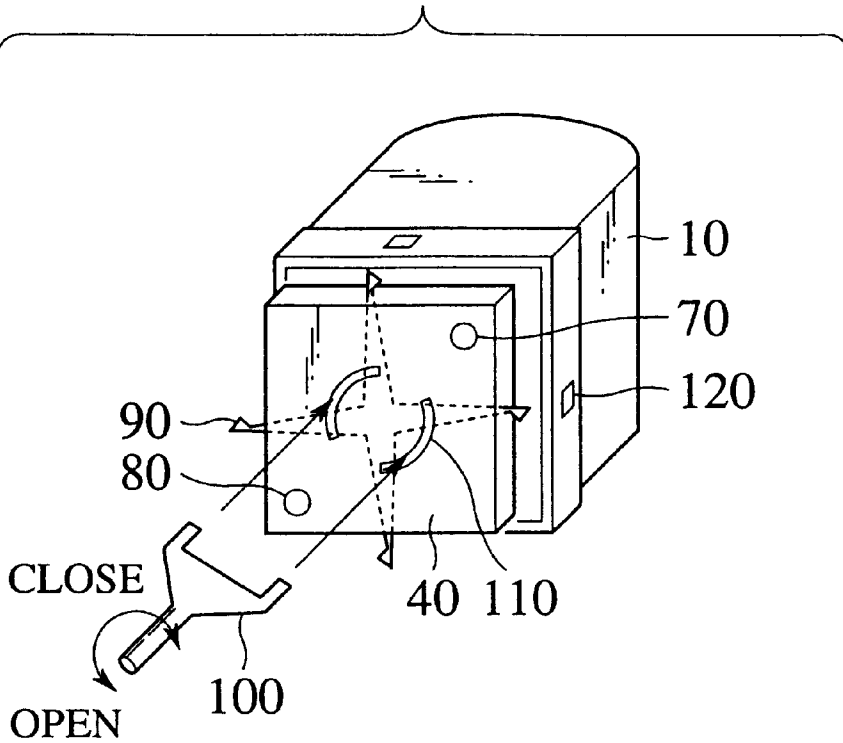


FIG.2B

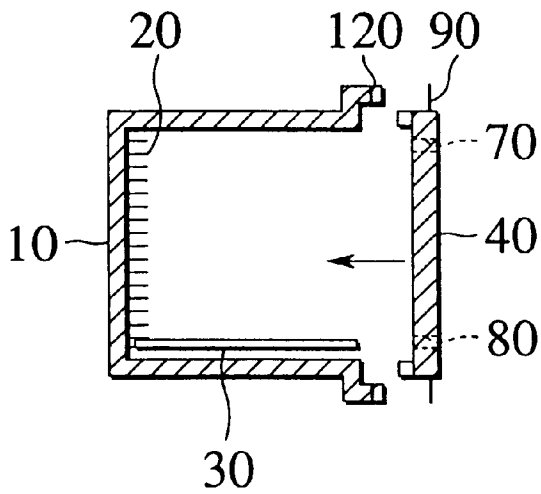


FIG.2C

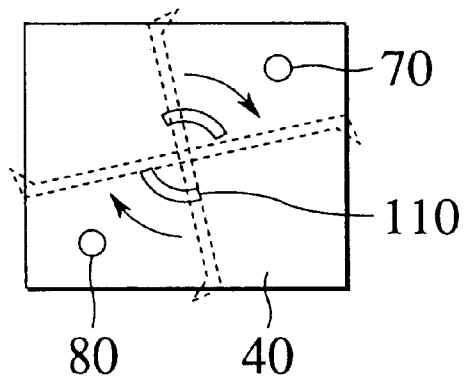


FIG.3A

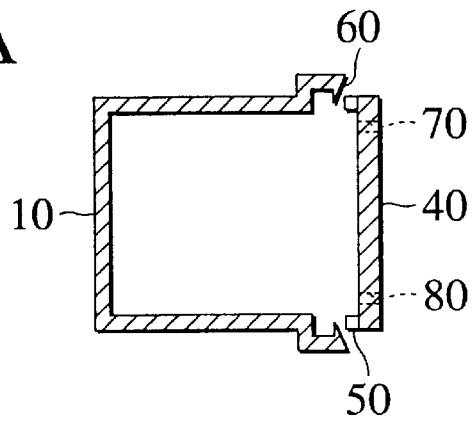


FIG.3B

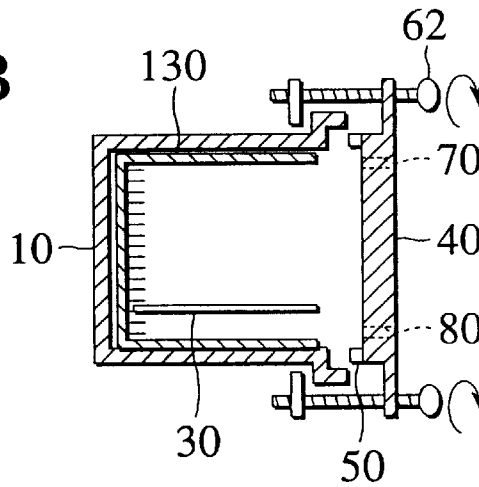


FIG.3C

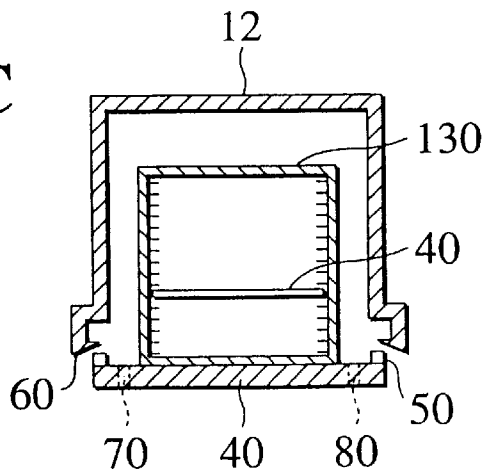


FIG.4A

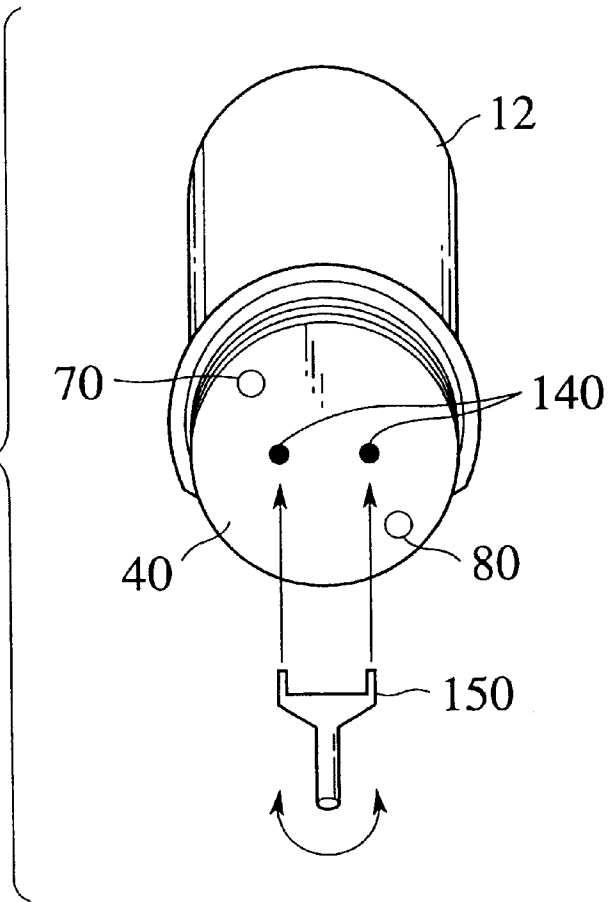


FIG.4B

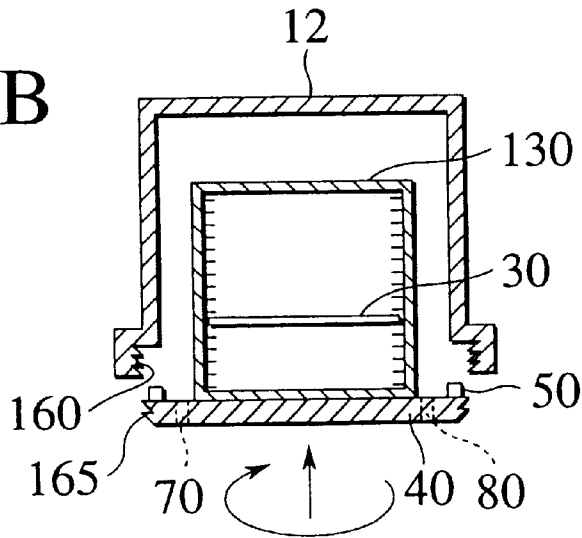


FIG.5A

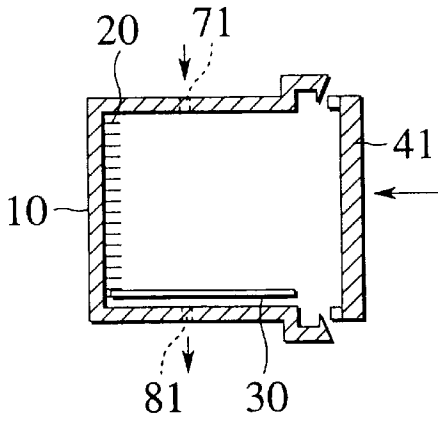


FIG.5B

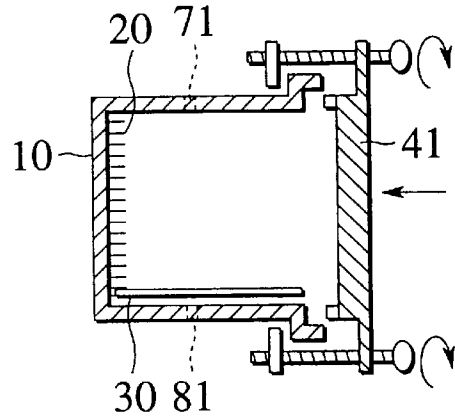


FIG.5C

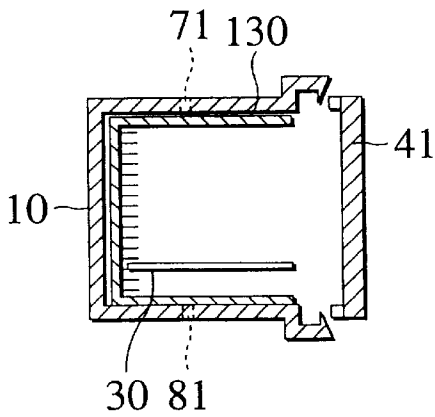


FIG.5D

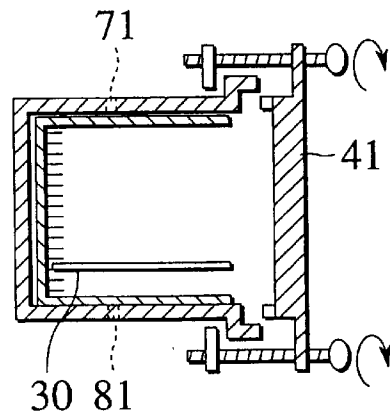


FIG.5E

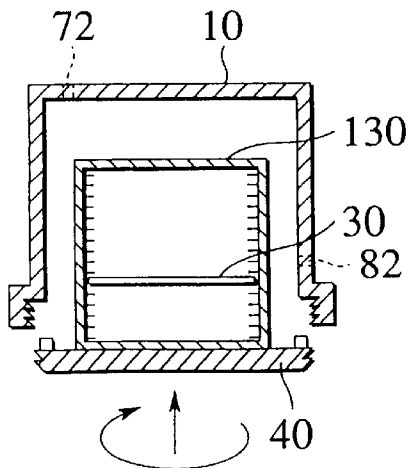


FIG. 6A

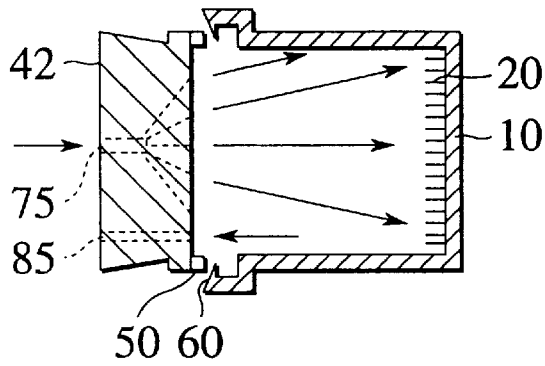


FIG. 6B

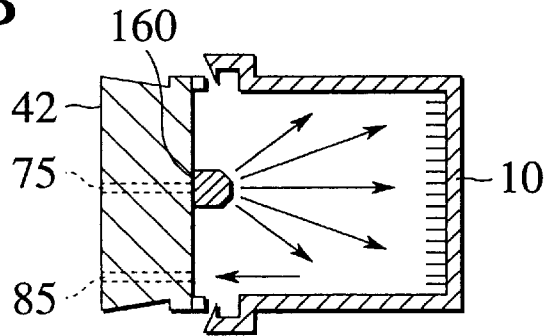


FIG. 6C

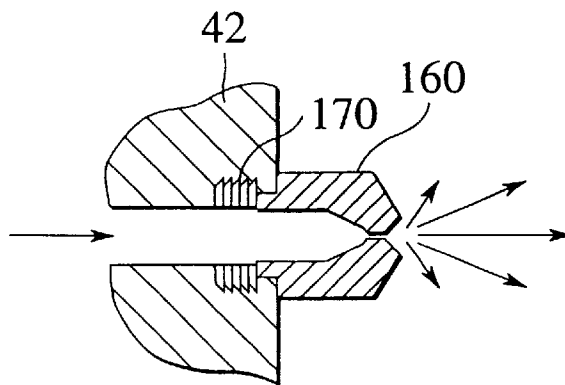


FIG. 7A

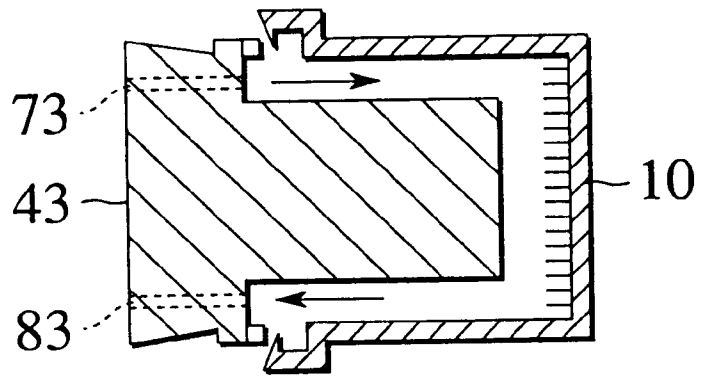


FIG. 7B

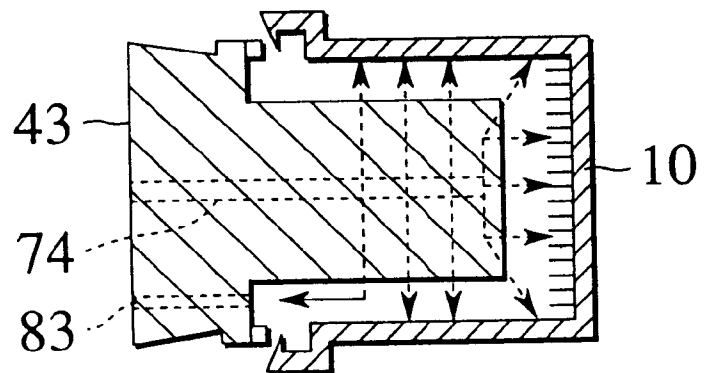


FIG. 8A

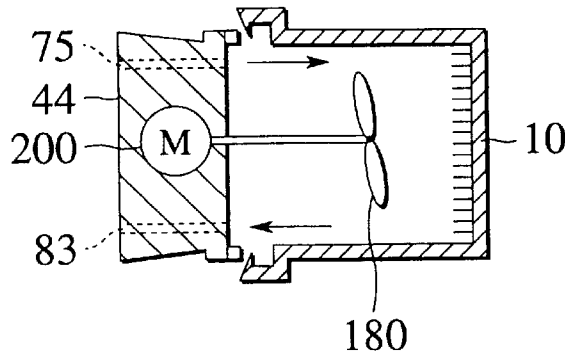


FIG. 8B

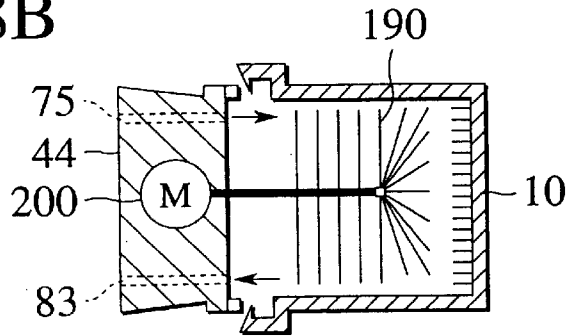


FIG. 8C

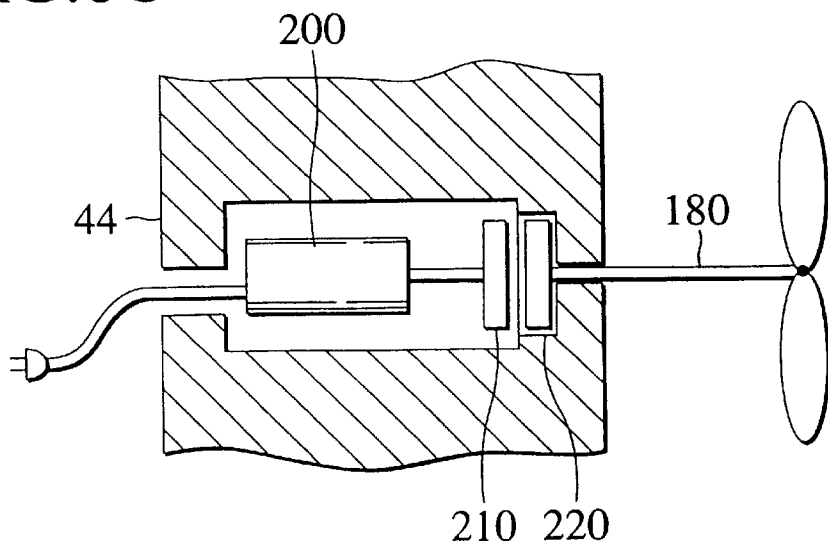


FIG.9A

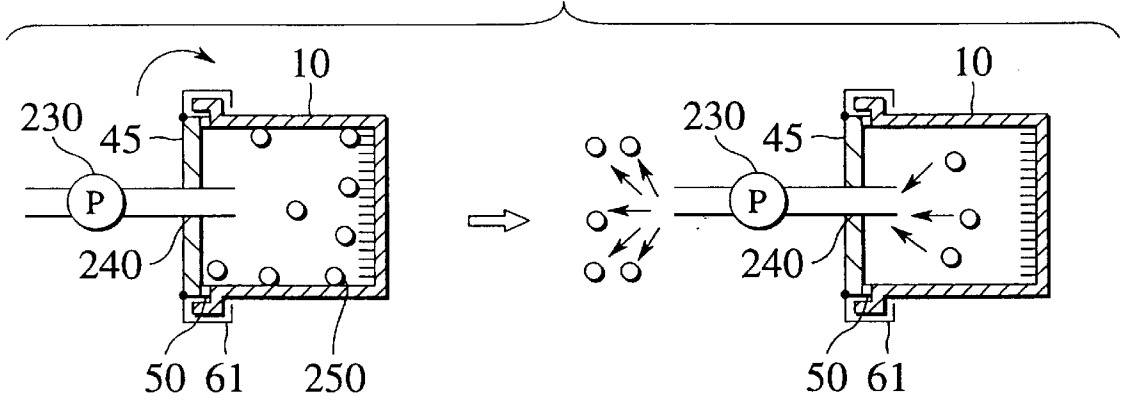


FIG.9B

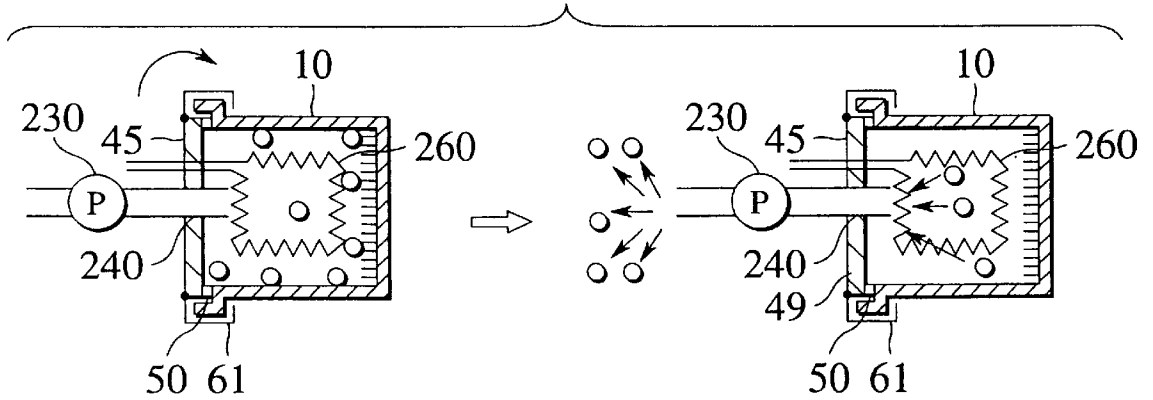


FIG. 10A

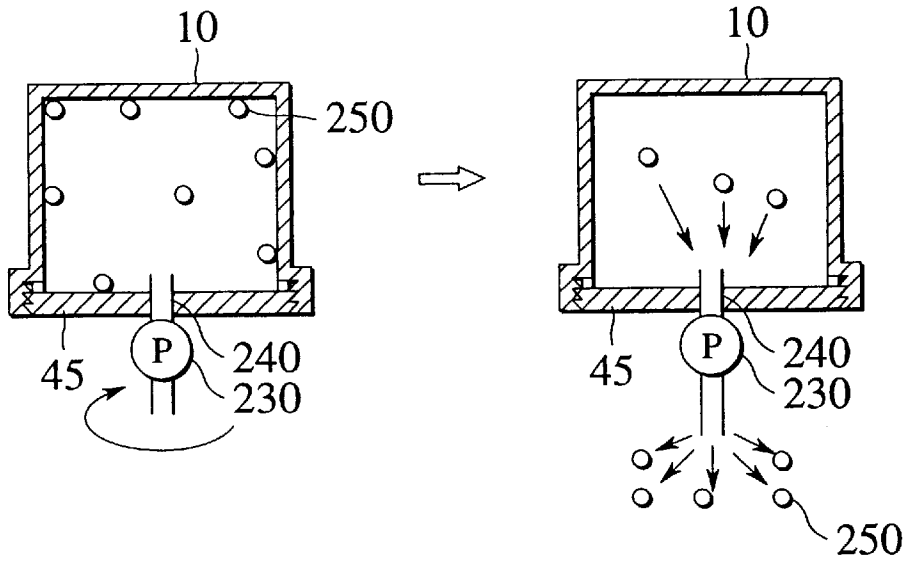


FIG. 10B

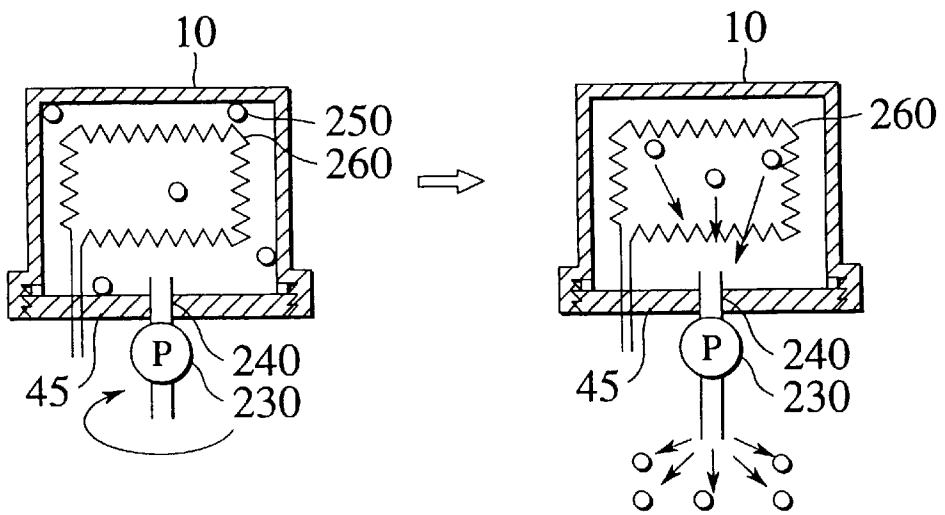


FIG. 11A

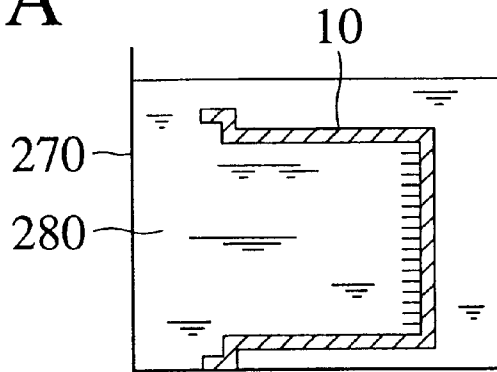


FIG. 11B

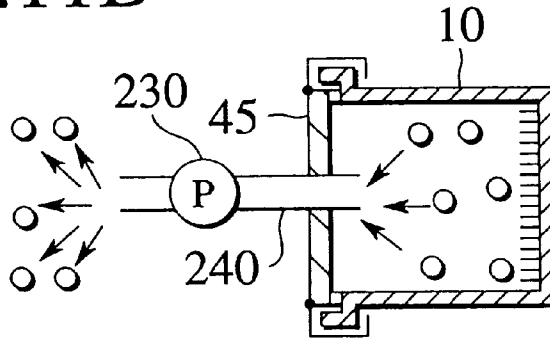


FIG. 11C

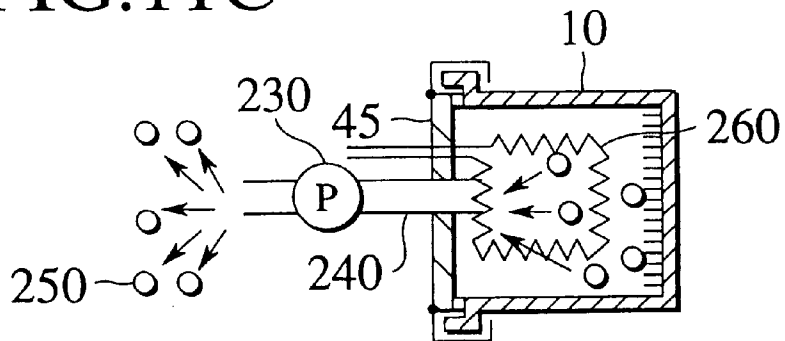


FIG. 12A

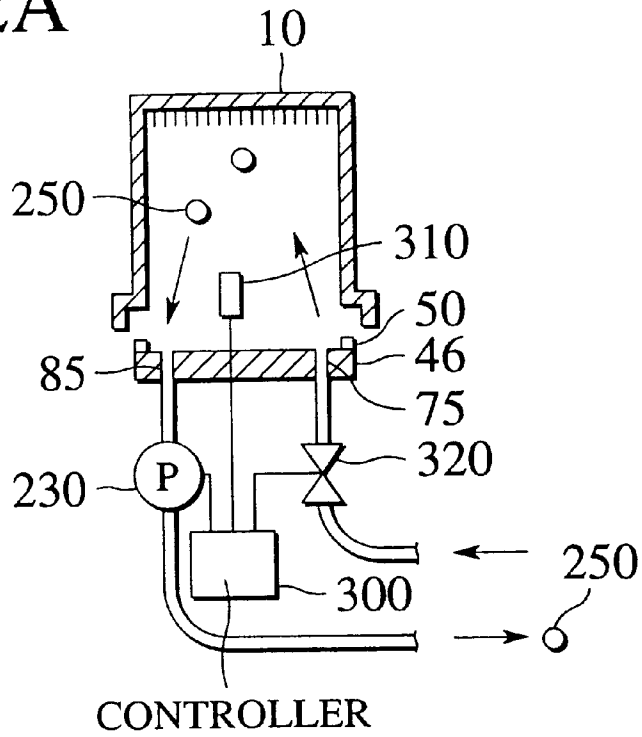


FIG. 12B

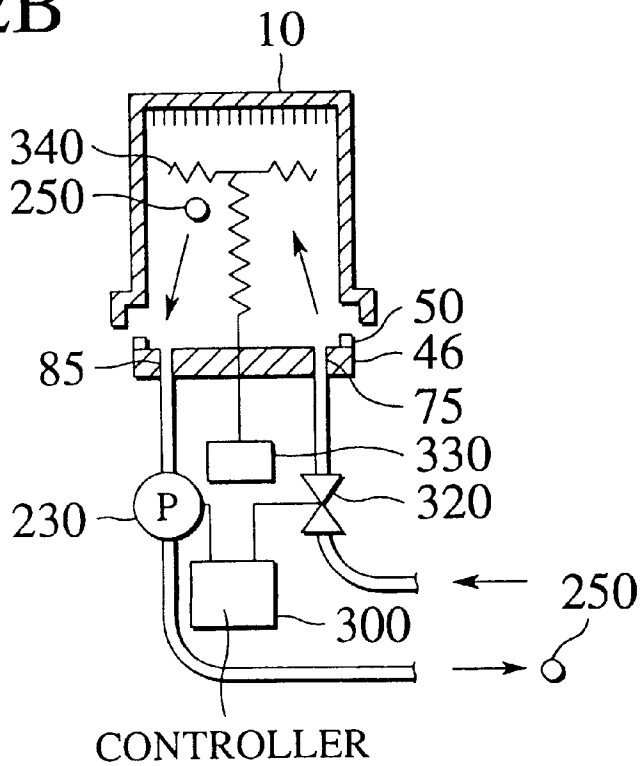


FIG. 13

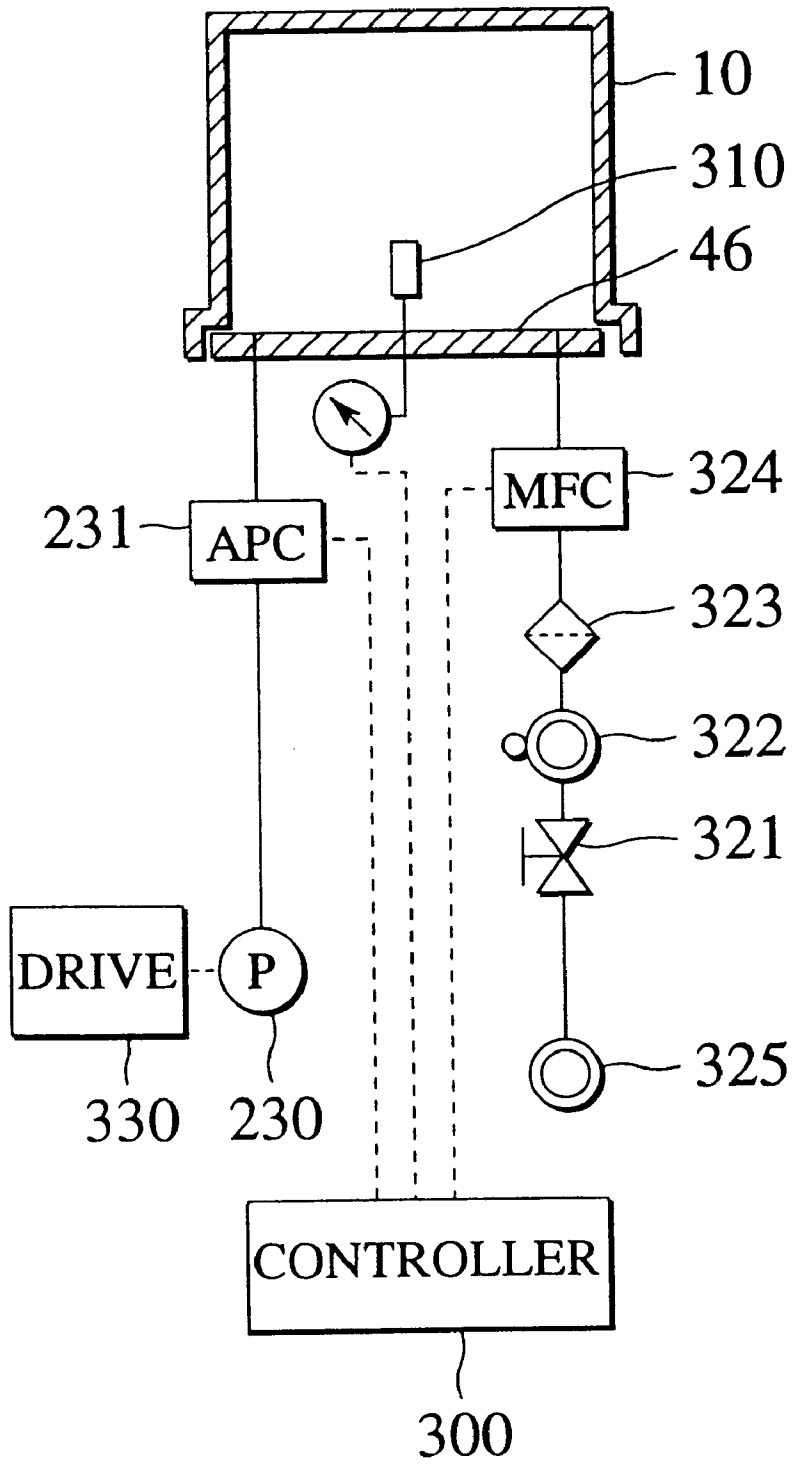


FIG. 14A

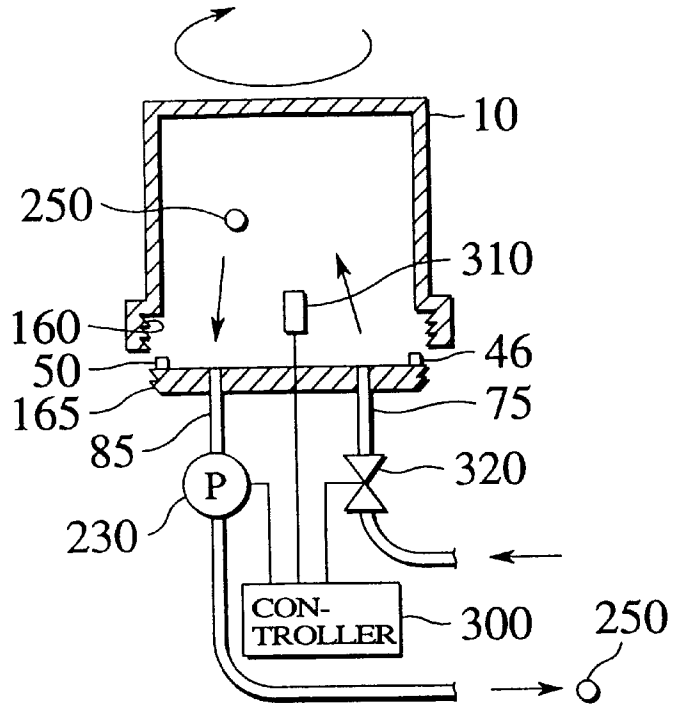


FIG. 14B

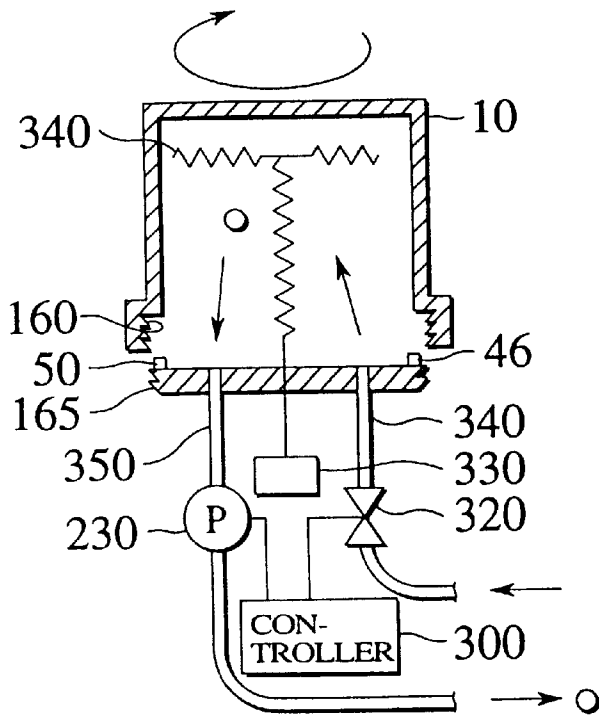


FIG. 15A

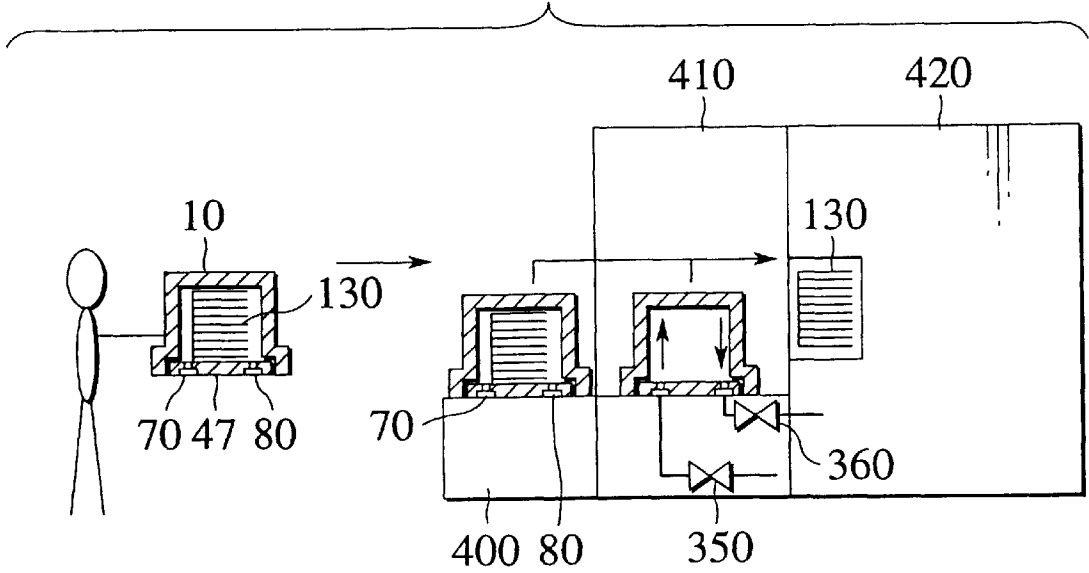


FIG. 15B

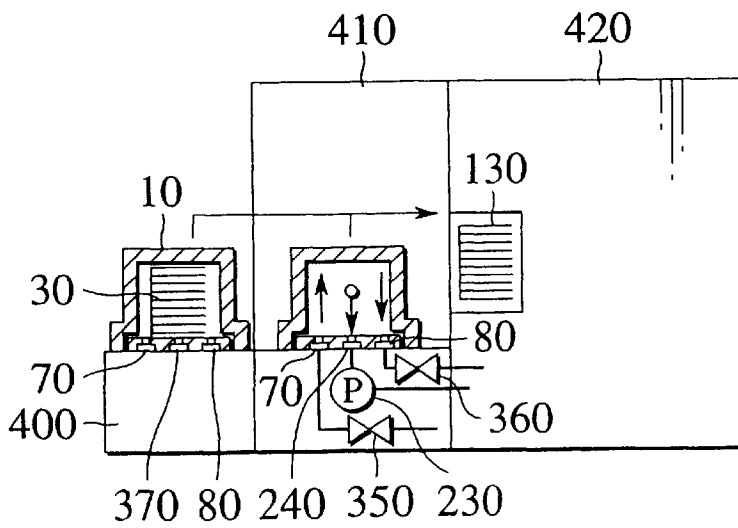


FIG. 16A

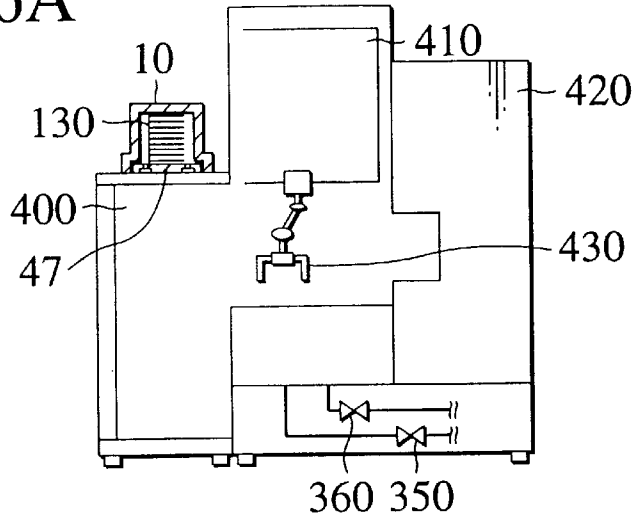


FIG. 16B

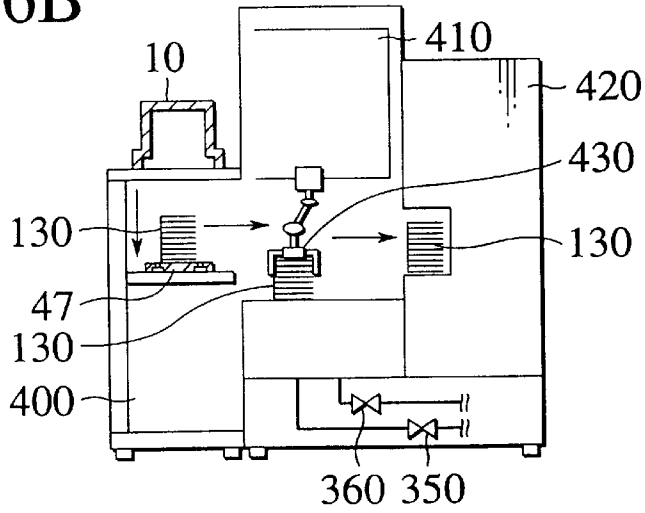


FIG. 16C

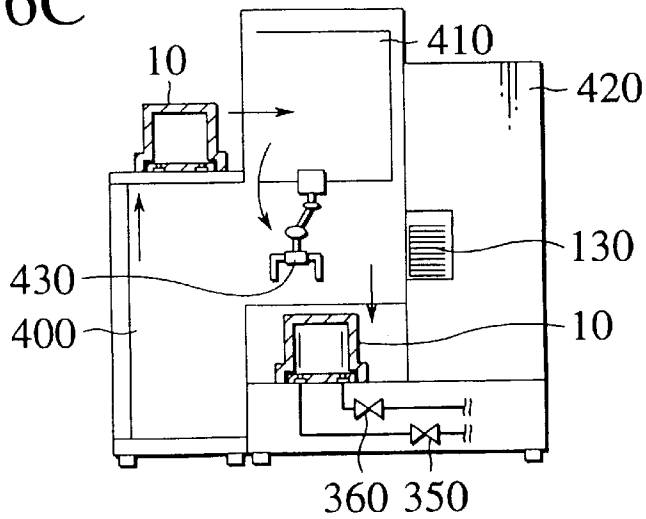


FIG. 17A

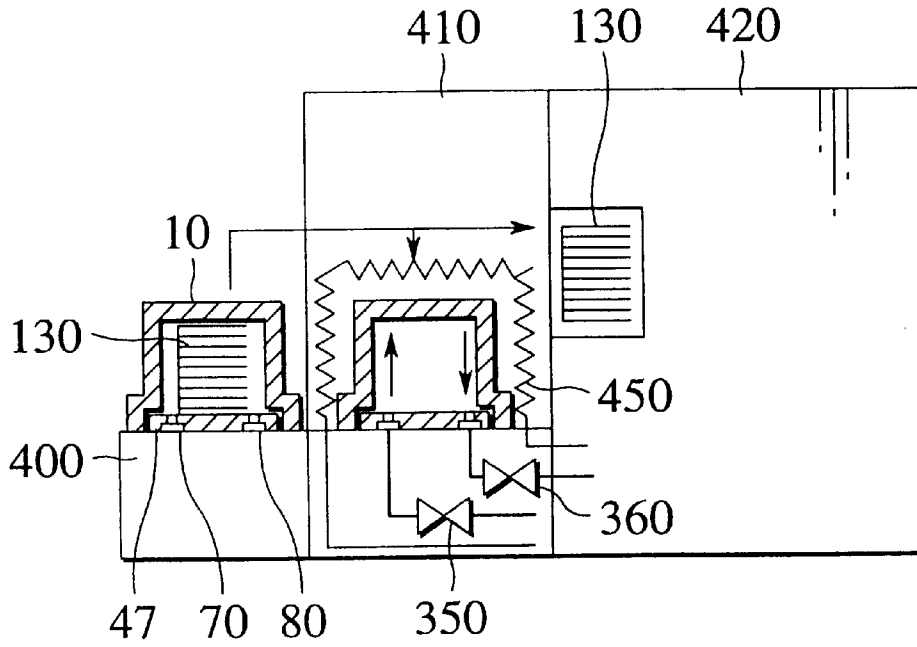


FIG. 17B

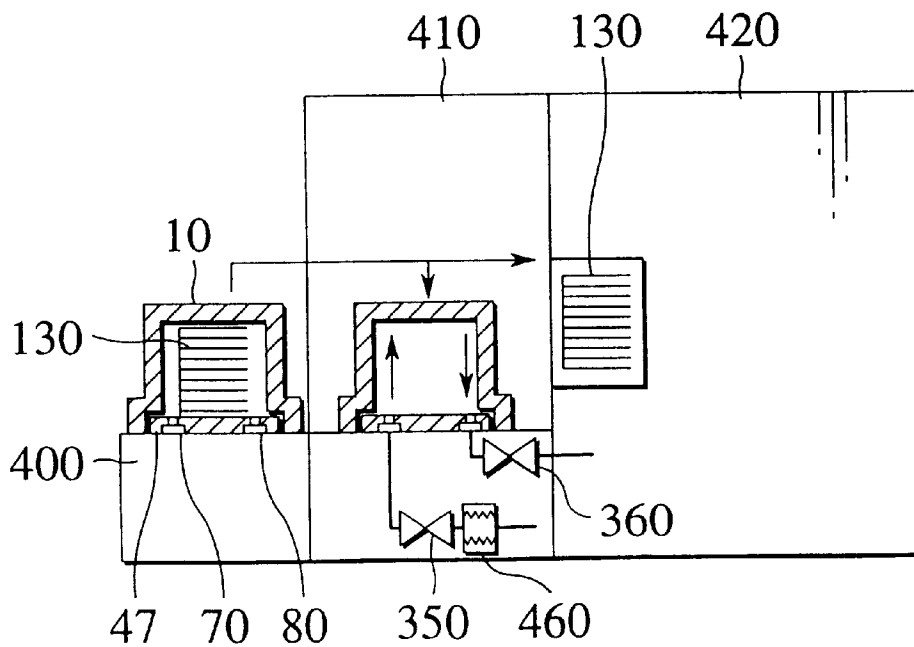


FIG. 18A

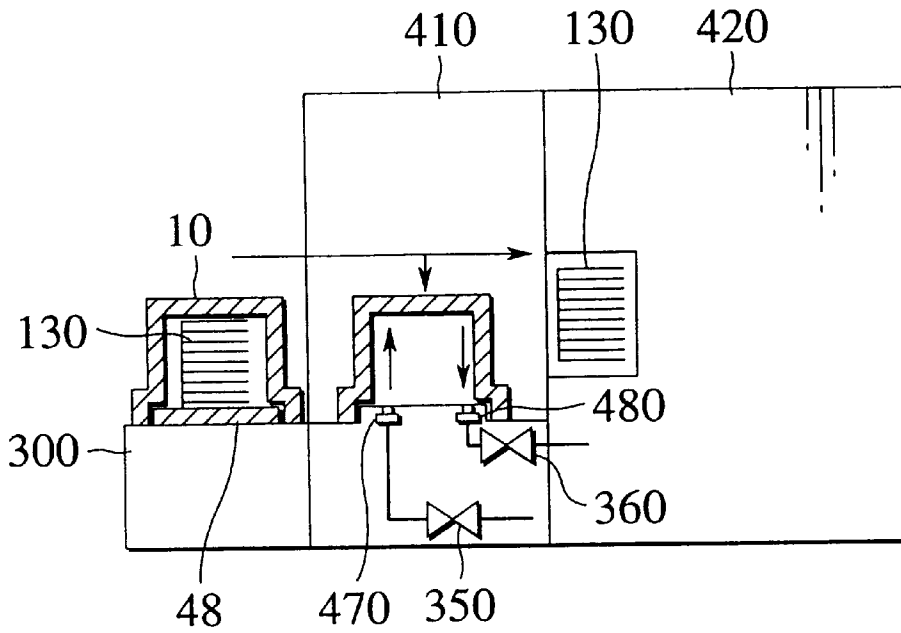


FIG. 18B

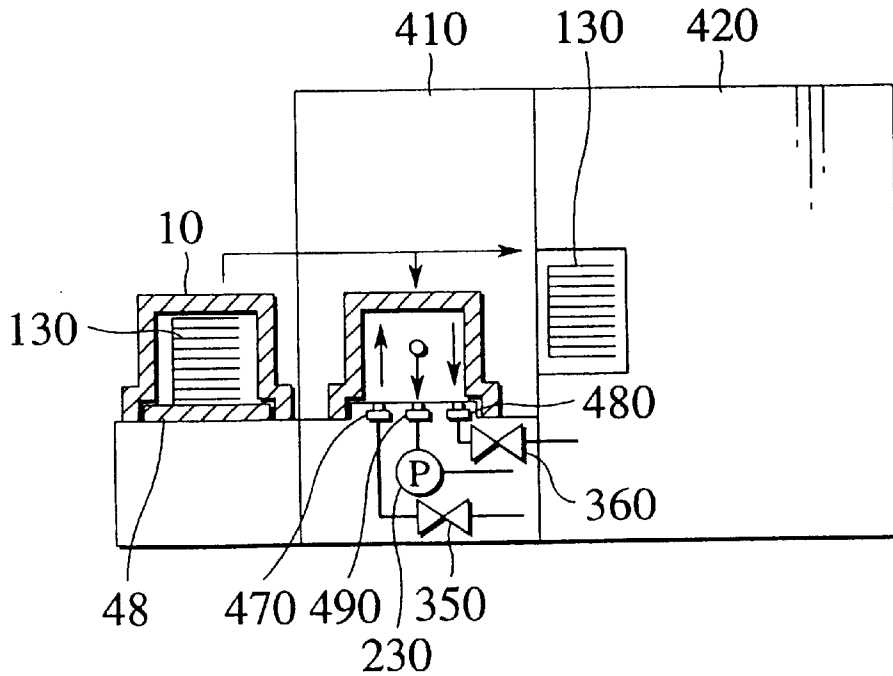


FIG. 19A

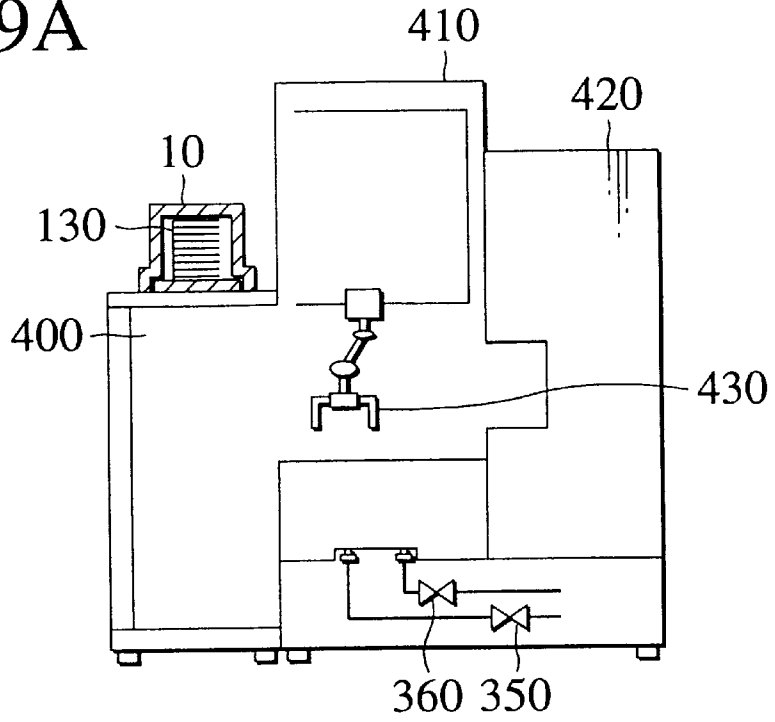


FIG. 19B

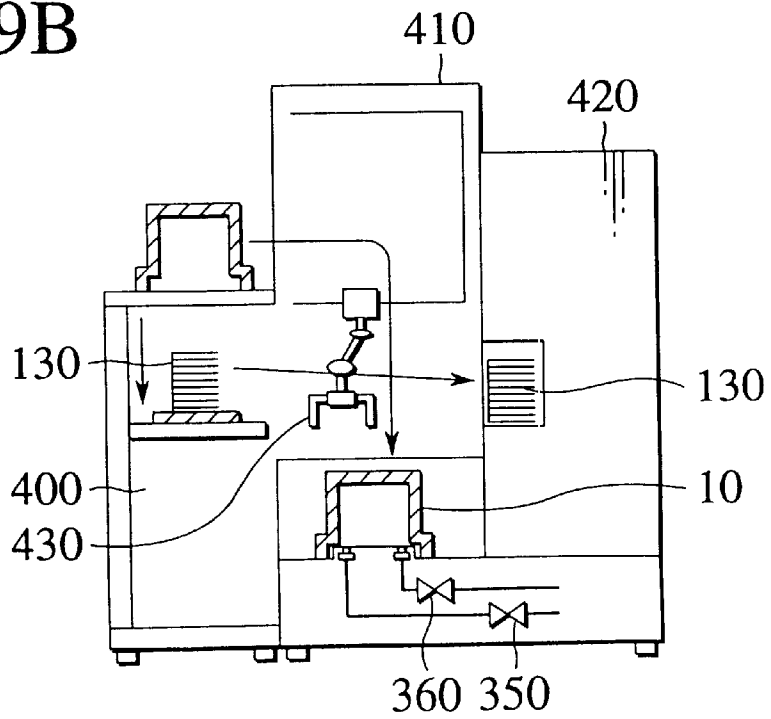


FIG.20A

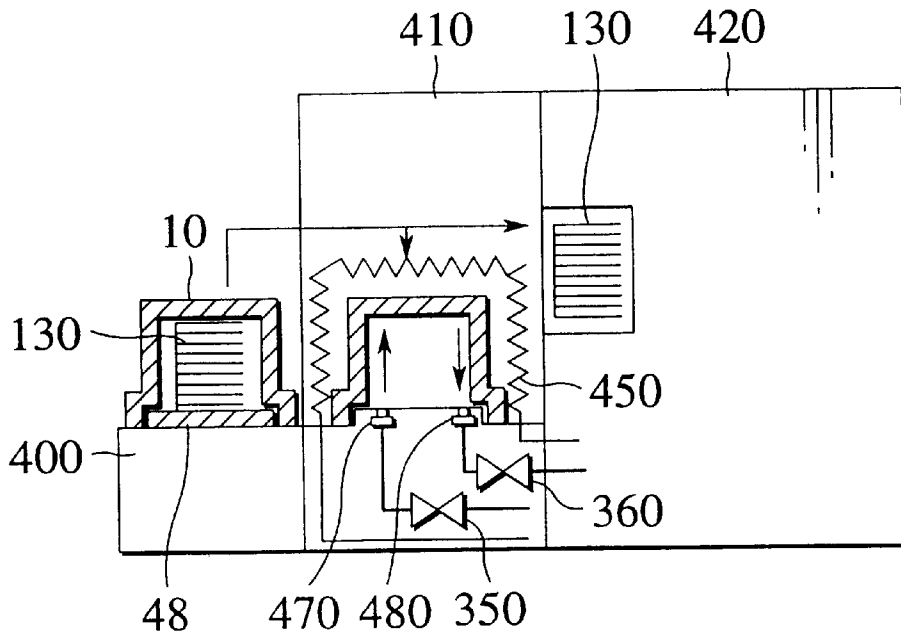


FIG.20B

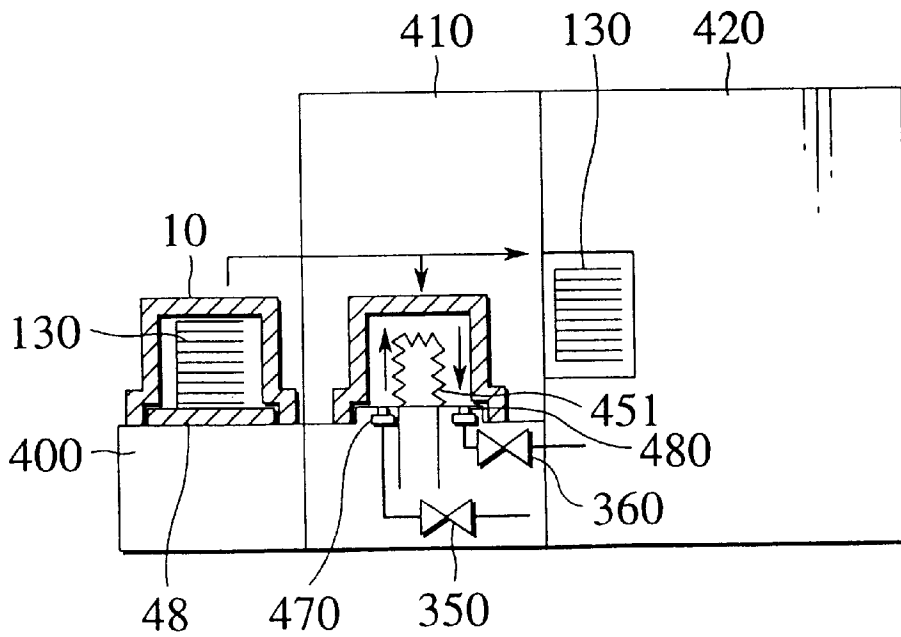


FIG.21A

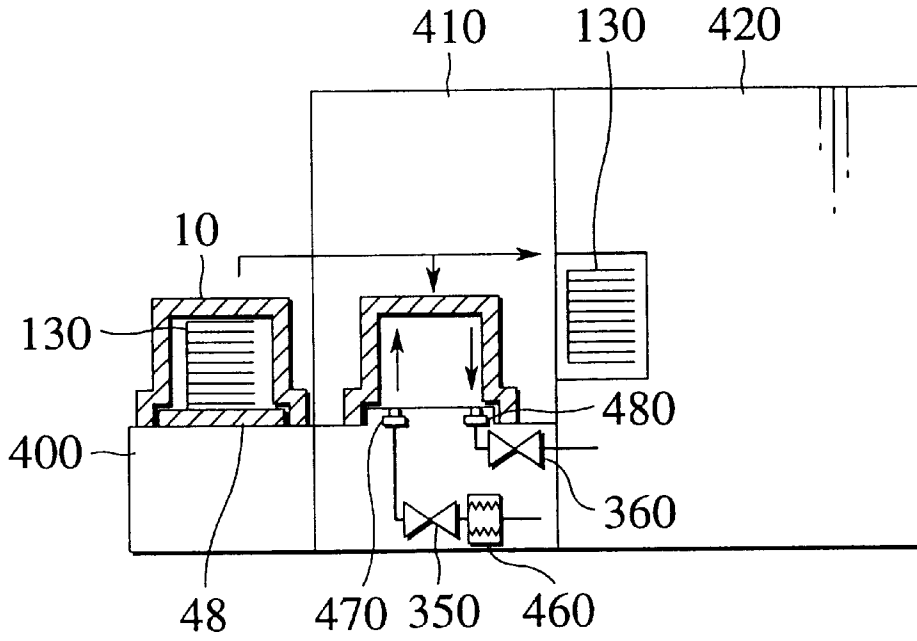


FIG.21B

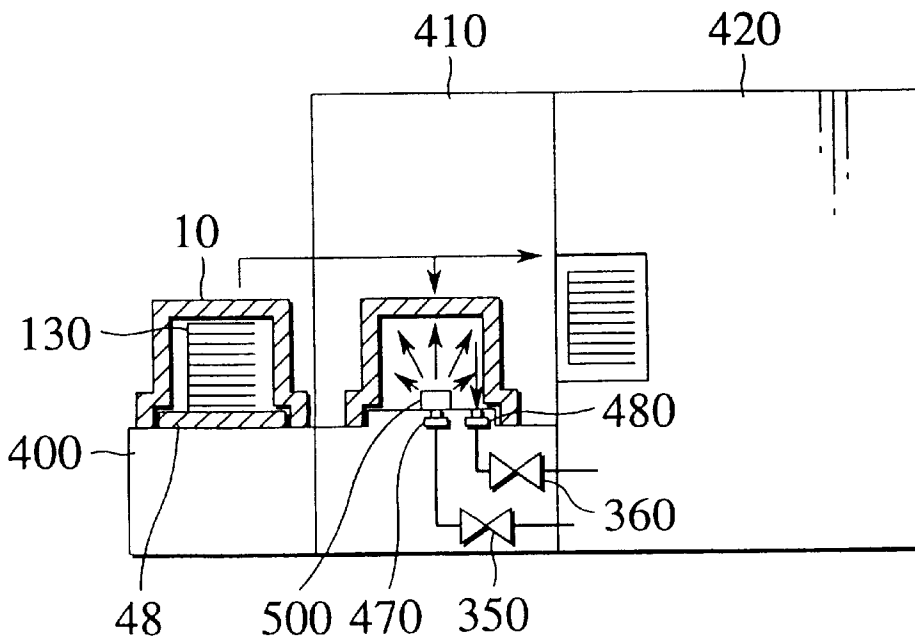


FIG.22A

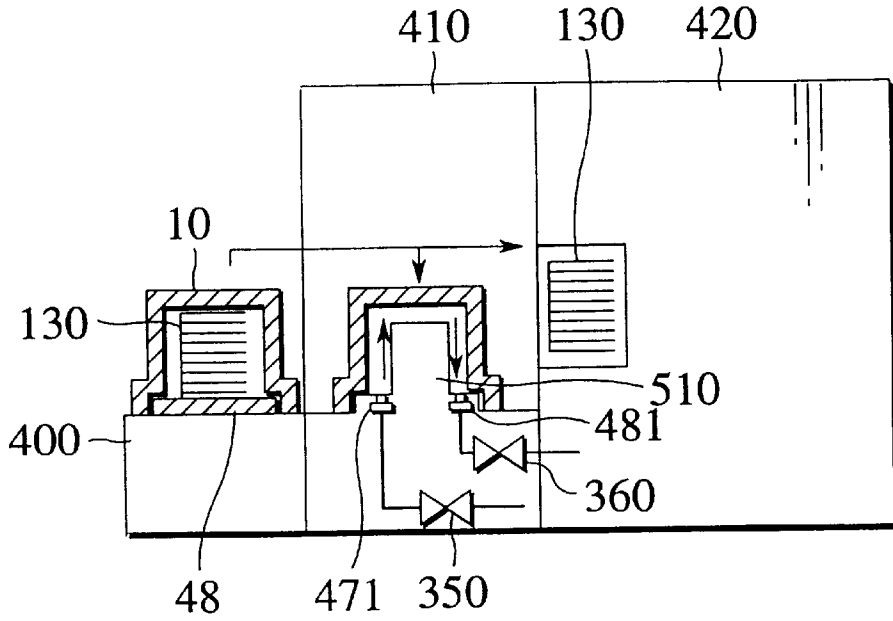


FIG.22B

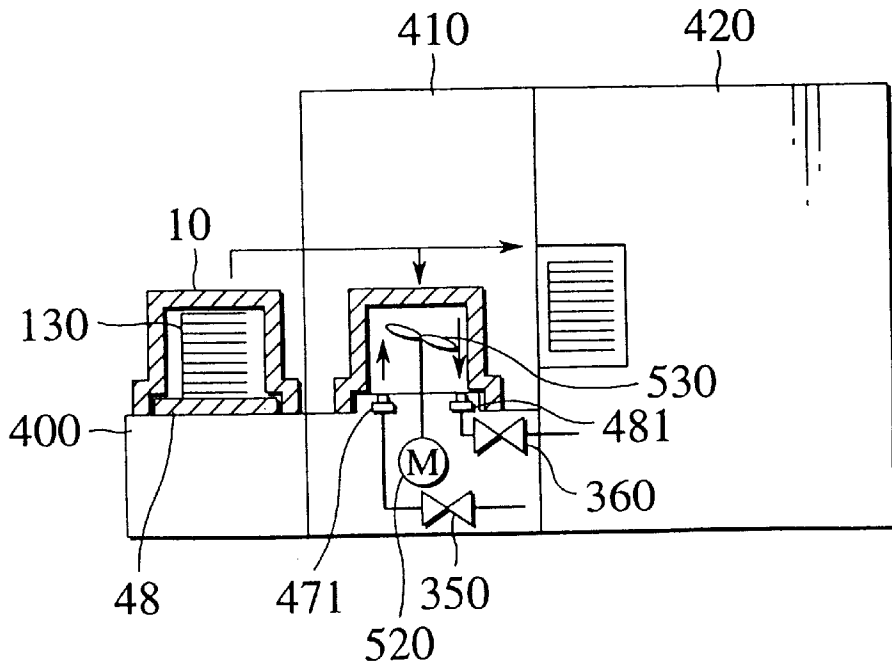


FIG. 23

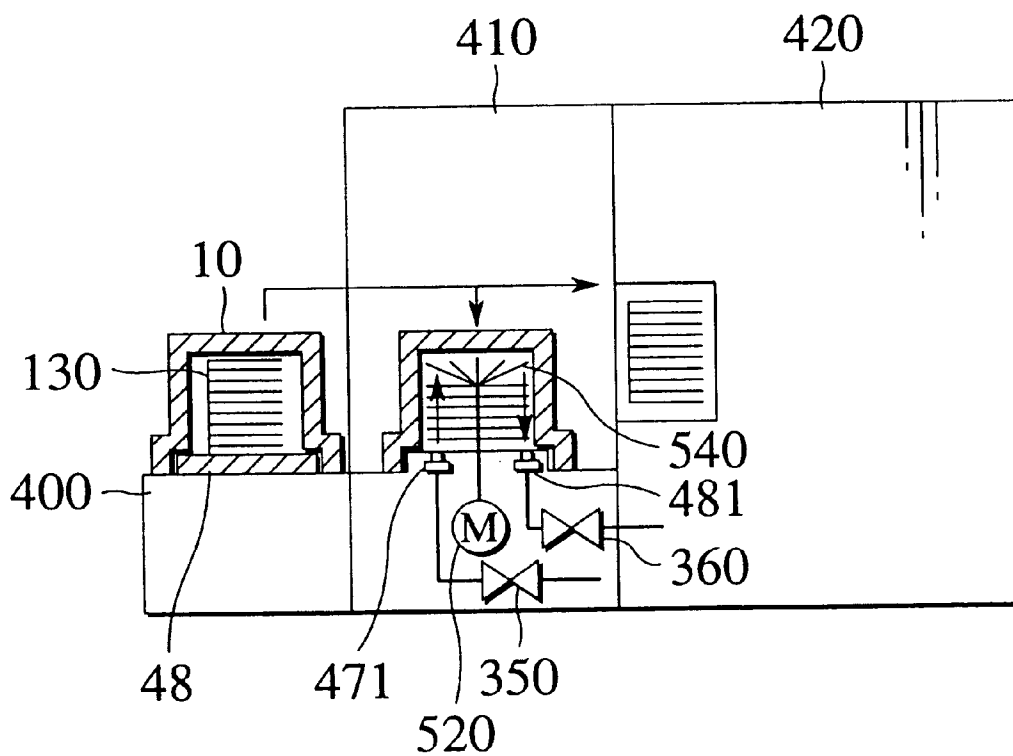


FIG. 24A

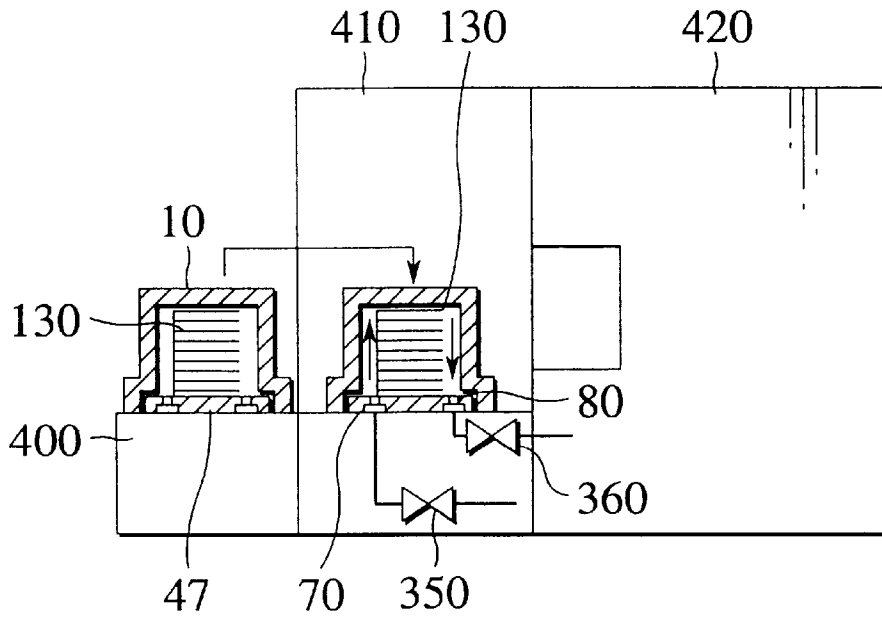


FIG. 24B

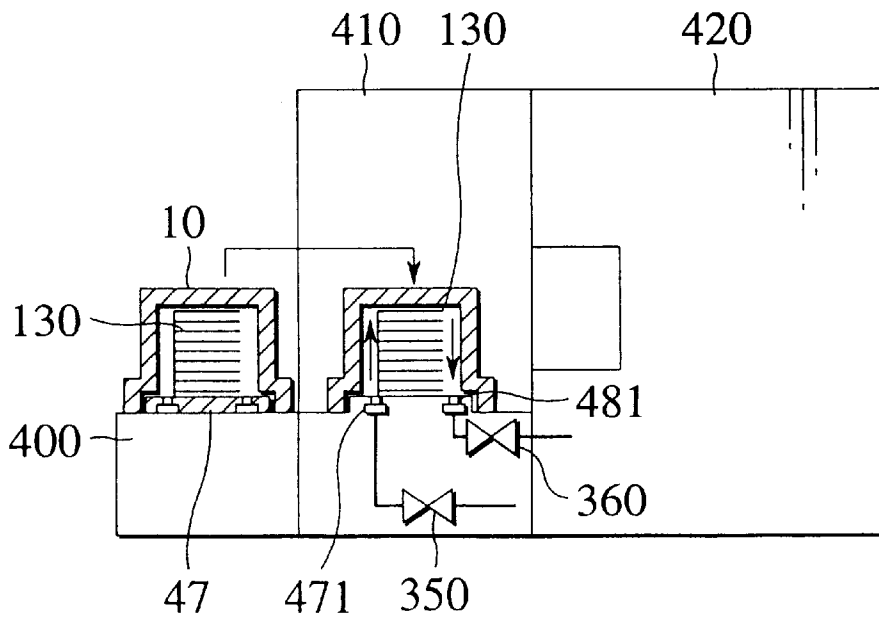


FIG.25A
PRIOR ART

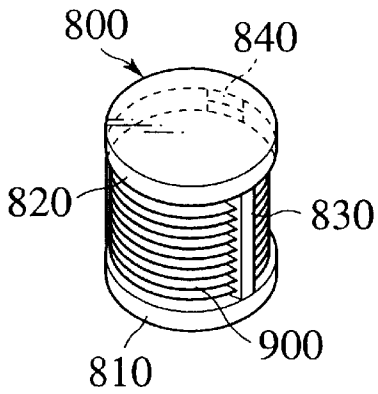


FIG.25B
PRIOR ART

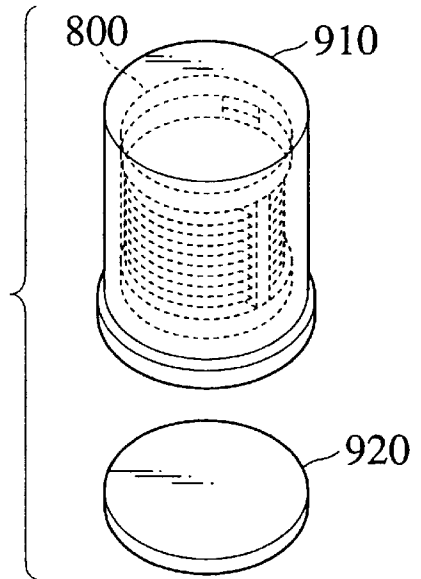


FIG.25C
PRIOR ART

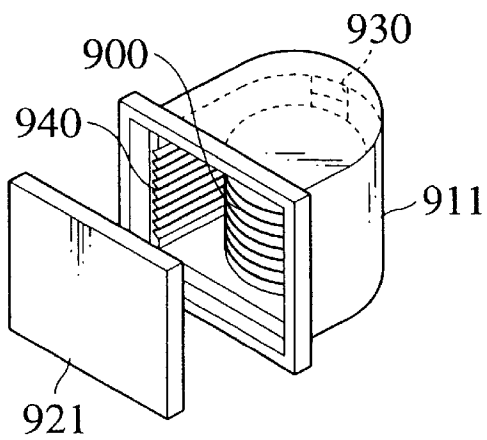


FIG.25D
PRIOR ART

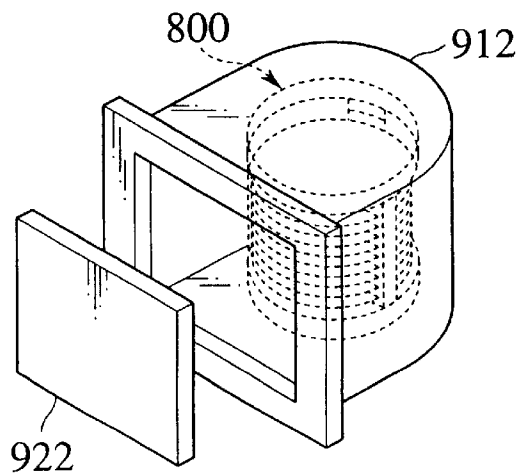


FIG.26A

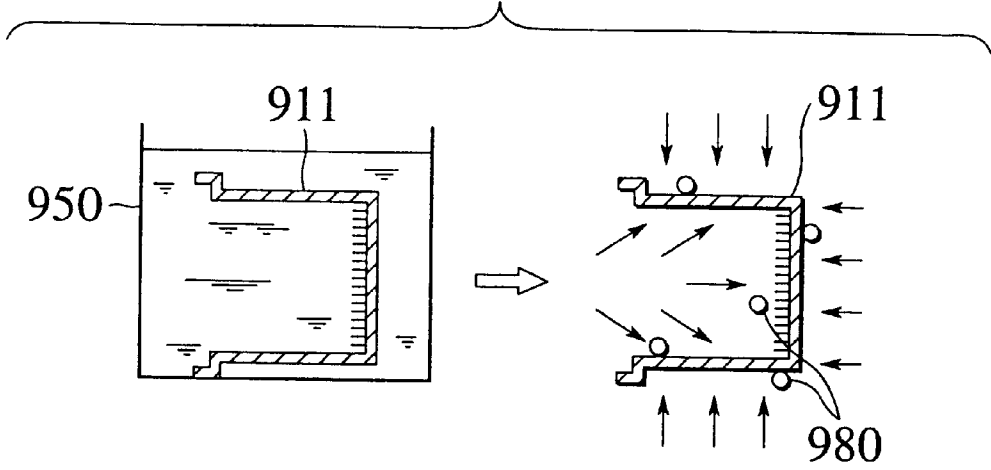
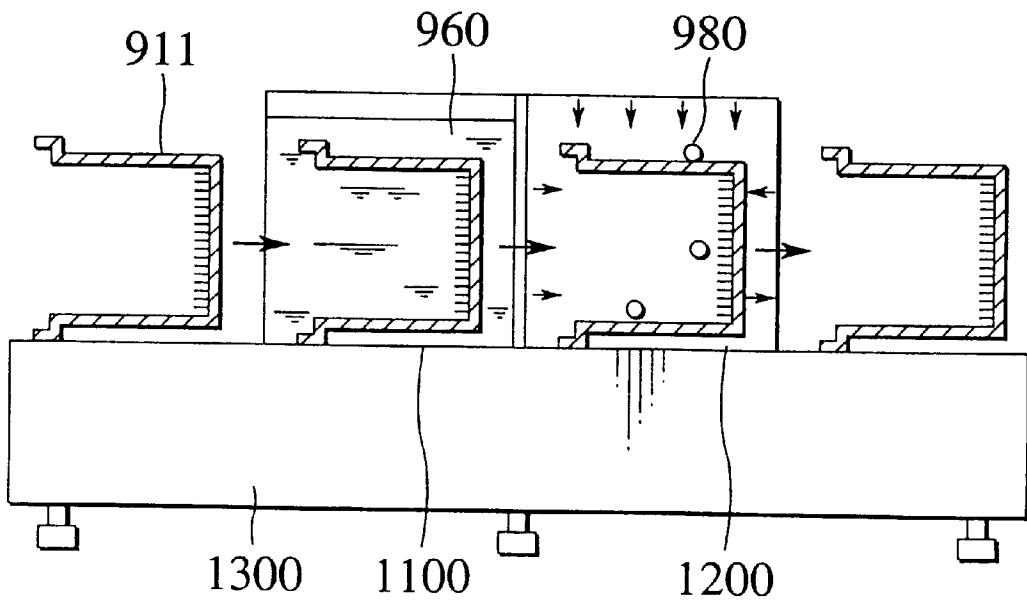


FIG.26B



POD AND METHOD OF CLEANING IT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a pod used to store and carry substrates or wafers, and particularly, to the structure of a pod that is easy to clean, a method of cleaning a pod, an apparatus for cleaning a pod, and an apparatus for processing substrates.

2. Description of the Related Art

Generally, substrates or wafers made of, for example, silicon (Si) are stored and carried in wafer cassettes during manufacturing. Each wafer cassette carries 13 or 25 wafers. The wafer cassettes with wafers are transferred between processing apparatuses such as film forming and etching apparatuses during manufacturing. A wafer/substrate transferring system that employs the wafer cassettes is called a cassette-to-cassette system.

FIG. 25A shows a conventional open-type wafer cassette 800. The cassette 800 consists of a top plate 820, a bottom plate 810, and three posts that support the top and bottom plates 820 and 810. The posts 830 have grooves for supporting wafers, and the post 840 serves as a stopper for preventing the wafers from dropping.

In place of such wafer cassettes, pods have been studied to store and carry substrates or wafers, to meet needs for highly integrated fine devices to be produced from the substrates or wafers.

FIGS. 25B, 25C, and 25D show pods presently studied. Each pod consists of a pod body and a cover. The pod body is a box having an opening for taking in and out wafers, and the cover closes the opening of the pod body. The pod of FIG. 25B has a bottom opening that is closed by a cover 920. The pods of FIGS. 25C and 25D have side openings that are closed by covers 921 and 922, respectively. The pods of FIGS. 25B and 25D store the conventional open-type wafer cassettes with wafers. The pod of FIG. 25C has grooves on the inner wall thereof, to directly hold wafers without a wafer cassette.

The pods are capable of storing and carrying wafers in a closed dust-free space, thereby improving the yield of semiconductor products to be produced from the wafers.

Recent wafers are large in diameter, size, and weight to improve productivity. For these large wafers, the conventional wafer cassettes involve a risk of dropping the wafers during carriage, and therefore, the pods are preferable for such large wafers.

The pods are advantageous in keeping dust-free environment for wafers and securing safe carriage. The pods, however, have some problems. This will be explained.

The open wafer cassettes can be washed while holding wafers. On the other hand, wafers stored in closed pods are unable to wash. To wash them, they must be taken out of the pods. This means that the pods themselves are rarely washed during wafer processing.

As a result, the insides of the pods are gradually contaminated. This deteriorates the cleanliness of wafers stored therein, thereby lowering the yield of semiconductor products to be produced from the wafers.

The pods may be washed separately from the wafers during wafer processing. To wash large pods that store 200-mm to 300-mm diameter wafers, a large washing tank is needed. FIG. 26A shows a washing tank 950 for washing a pod 911. The tank 950 must be larger than the pod 911, and

if the pod 911 is large, the tank 950 must be very large. FIG. 26B shows a pod washing apparatus having a washing tank 960 and a dryer chamber 980. This apparatus is very large. In a limited space in a clean room, such a large apparatus is hardly acceptable.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a pod that is easy to clean, a method of cleaning a pod, an apparatus for cleaning a pod, and a semiconductor processing apparatus having a pod cleaning system.

In order to accomplish the object, a first aspect of the present invention provides a pod for storing substrates, having a pod body provided with an opening for taking in and out the substrates, a cover removably attached to the opening, and a fixing unit for fixing the pod body and cover together to tightly close the pod body. The cover has an inlet for introducing fluid into the pod and an outlet for discharging the fluid from the pod.

The first aspect tightly closes the pod body with the cover, introduces a washing fluid into the pod through the inlet, and discharges the washing fluid from the pod through the outlet. This aspect needs no separate washing tank to clean the inside of the pod because it uses the pod itself as a washing tank.

A second aspect of the present invention provides a pod for storing substrates, having a pod body provided with an opening for taking in and out the substrates, a cover removably attached to the opening, and a fixing unit for fixing the pod body and cover together to tightly close the pod body. The pod body has an inlet for introducing fluid into the pod and an outlet for discharging the fluid from the pod.

The second aspect tightly closes the pod body with the cover, introduces a washing fluid into the pod through the inlet, and discharges the washing fluid from the pod through the outlet. This aspect needs no separate washing tank to clean the inside of the pod because it uses the pod itself as a washing tank.

A third aspect of the present invention provides a pod for storing substrates, having a pod body provided with an opening for taking in and out the substrates, a cover removably attached to the opening, and a fixing unit for fixing the pod body and cover together to tightly close the pod body. The cover is provided with a nozzle for jetting fluid into the pod and an outlet for discharging the fluid from the pod.

The third aspect tightly closes the pod body with the cover, jets a washing fluid into the pod through the nozzle, and discharges the washing fluid from the pod through the outlet. This aspect needs no separate washing tank to clean the inside of the pod because it uses the pod itself as a washing tank. The nozzle showers a washing fluid of high pressure into the pod, thereby improving the physical cleaning power of the washing fluid in the pod.

A fourth aspect of the present invention provides an apparatus for cleaning a pod for storing substrates. The apparatus has a cover and a discharge pump. The pod has an opening for taking in and out substrates. The cover is removably attached to the opening and has an outlet for discharging gas from the pod. The discharge pump is connected to the outlet of the cover.

The fourth aspect tightly attaches the cover to the pod and evacuates impurity gases from the pod through the outlet, thereby cleaning the inside of the pod.

A fifth aspect of the present invention provides an apparatus for cleaning a pod for storing substrates. The pod has

an opening formed on one face thereof to take in and out substrates. The apparatus has a cover to be removably attached to the opening of the pod, an inlet formed on the cover to guide gas into the pod, an outlet formed on the cover to discharge gas from the pod, a gas supply source connected to the inlet of the cover, a gas adjuster arranged between the inlet of the cover and the gas supply source to adjust the flow rate of gas, a vacuum pump connected to the outlet of the cover, a pressure sensor for measuring a pressure in the pod, and a controller electrically connected to the gas adjuster, vacuum pump, and pressure sensor.

The fifth aspect sets a washed pod in the apparatus, evacuates remnants from the pod, and fills the pod with an inert gas.

A sixth aspect of the present invention provides an apparatus for processing substrates. The apparatus has a pod reception chamber, a pod processing chamber, a substrate processing chamber, and a transfer unit for transferring the pod and substrates between these chambers. The pod has an opening on one face thereof to take in and out substrates and a cover to be removably attached to the opening. The pod reception chamber has a unit for receiving a pod with substrates from the outside and a unit for taking the substrates out of the pod. The pod processing chamber has a unit for cleaning the inside of the pod. The substrate processing chamber has a unit for processing the substrates.

The sixth aspect cleans the inside of the pod in the pod processing chamber while processing the substrates in the substrate processing chamber.

The cover of the pod of the sixth aspect may have an inlet for guiding fluid into a pod and an outlet for discharging fluid from the pod. The unit for cleaning the inside of a pod may have a unit for fixing the opening of the pod and the cover together to tightly close the pod, a unit for introducing a washing liquid into the pod through the inlet of the cover, and a unit for discharging the washing liquid from the pod through the outlet of the cover. The cover may have a second outlet for discharging gas and a heater.

The unit for cleaning the inside of a pod may have a table for tightly closing the pod set on the table, an inlet formed on the table to introduce fluid into the pod, an outlet formed on the table to discharge fluid from the pod, a unit for introducing a washing liquid into the pod through the inlet, and a unit for discharging the washing liquid from the pod through the outlet. The table may have a second outlet for discharging gas and a heater.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A to 4B are sectional and perspective views showing pods according to an embodiment 1 of the present invention;

FIGS. 5A to 5E are sectional views showing pods according to an embodiment 2 of the present invention;

FIGS. 6A to 6C are sectional views showing pods according to an embodiment 3 of the present invention;

FIGS. 7A and 7B are sectional views showing pods according to an embodiment 4 of the present invention;

FIGS. 8A to 8C are sectional views showing pods according to an embodiment 5 of the present invention;

FIGS. 9A to 10B are sectional views showing covers for cleaning and drying pods, according to an embodiment 6 of the present invention;

FIGS. 11A to 11C are sectional views showing covers for cleaning and drying pods, according to an embodiment 7 of the present invention;

FIGS. 12A to 14B are sectional views showing pod washing apparatuses according to an embodiment 8 of the present invention;

FIGS. 15A to 24B are sectional views showing semiconductor processing apparatuses according to an embodiment 9 of the present invention;

FIGS. 25A to 25D are perspective views showing wafer cassettes and pods according to prior arts; and

FIGS. 26A and 26B are sectional views showing a pod washing process and a pod washing apparatus according to prior arts.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Various embodiments of the present invention will be described with reference to the accompanying drawings.

[Embodiment 1]

FIGS. 1A to 4B show pods according to the embodiment 1 of the present invention. The pods of the embodiment 1 are characterized by a structure that is easy to wash and by a cover that is provided with an inlet and outlet for fluid.

(Embodiment 1-1)

FIGS. 1A and 1B are sectional and perspective views showing a pod according to an embodiment 1-1 of the present invention. The pod consists of a pod body 10 and a cover 40. The pod body 10 has an opening formed on a side face thereof to take in and out wafers or substrates. The cover 40 is removably attached to the opening.

The inner wall of the pod body 10 has grooves at regular intervals to horizontally support wafers. Namely, the pod can directly store wafers without a wafer cassette. The grooves may be formed partially on the inner wall of the pod body 10, to support the wafers at two or three positions.

The plan shape of the pod body 10 may be curved in alignment with the shape of wafers stored therein.

Along the opening of the pod body 10, there is a fitting part 60 having a hooking end to hold the cover 40. The periphery of the cover 40 corresponding to the periphery of the opening of the pod body 10 is provided with a seal frame 50 so that the pod body 10 and cover 40 are tightly attached together. When the cover 40 is fitted to the pod body 10, the hooking end of the fitting part 60 warps toward the outside of the cover 40 and pushes the cover 40 inwardly from the outside, thereby tightly fixing the cover 40 to the pod body 10.

The pod of the embodiment 1-1 is characterized by an inlet 70 and an outlet 80 formed on the cover 40. The inlet and outlet are used to wash the inside of the pod.

The cover 40 is fitted to the pod body 10 to tightly close the inside of the pod body 10. The inlet 70 and outlet 80 are connected to pipes, and an acid or alkaline washing liquid is introduced into the pod through the pipe and inlet 70. At this time, the outlet 80 is closed to fill the pod with the washing liquid. Since the pod body 10 and cover 40 are tightly fitted together, the washing liquid never leaks outside.

The pod filled with the washing liquid is kept as it is for a set time to etch off contaminants adhering to the inner wall of the pod. Thereafter, the outlet 80 is opened to discharge the washing liquid from the pod. Rinsing pure water is supplied into the pod through the inlet 70. While the pure water is being poured into the pod, the liquid in the pod is gradually discharged from the outlet 80. Instead of the acid

or alkaline washing liquid, a surfactant may be used. After rinsing the pod with the pure water, alcohol may be used to again wash the pod.

The locations of the inlet **70** and outlet **80** are not particularly limited. It is preferable that the inlet **70** is positioned close to the top of the pod and the outlet **80** close to the bottom of the pod to make the washing process easier.

The embodiment 1 is capable of washing pods without a separate washing tank or a bulky washing apparatus because it uses each pod itself as a washing tank. As a result, the embodiment 1 is inexpensive and saves the space of a clean room.

When washing a pod, wafers **30** may be left in the pod as shown in FIG. 1A so that not only the pod but also the wafers are cleaned.

The material of the pod is not particularly limited. It may be made of polycarbonate, metal, ceramics, resin, etc. A proper washing liquid must be selected so that it does not hurt the pod.

In FIG. 1A, the pod body **10** and cover **40** are fitted together with the fitting part **60** formed on the pod body **10**. Any other fitting arrangement is employable to fix the pod body **10** and cover **40** together.

Examples of fitting arrangements are shown in FIGS. 1C to 2C. In FIG. 1C, a cover **40** has fixings **61** to tightly fit the cover **40** to a pod body **10**. In FIG. 1D, bolts and nuts **62** fix a pod body **10** and cover **40** together.

In FIG. 2A, a cover **40** incorporates a rotatable cross hook **90**. Grooves **110** are formed on the cover **40**. A rotary tool **100** is inserted into the grooves **110** and is turned to turn the cross hook **90**. Before fitting the cover **40** to a pod body **10**, the cross hook **90** is retracted in the cover **40**. After the cover **40** is attached to the pod body **10**, the rotary tool **100** is inserted into the grooves **110** and is turned clockwise, so that the tips of the cross hook **90** may catch holes **120** formed at the periphery of the opening of the pod body **10**. This tightly fixes the pod body **10** and cover **40** together.

The covers **40** of FIGS. 2A to 2C have each an inlet **70** and an outlet **80** to clean the insides of pods as explained above.

(Embodiment 1-2)

FIGS. 3A to 4B are sectional and perspective views showing pods according to an embodiment 1-2 of the present invention.

The pod of FIG. 3A has no grooves on the inner wall thereof to support wafers. Namely, wafers are stored in an open-type wafer cassette **130**, which is stored in the pod. Except the wafer supporting grooves, the pod of FIG. 3A is the same as the pod of FIG. 1A. Namely, the pod of FIG. 3A is characterized by a cover **40** having an inlet **70** and an outlet **80**.

After the cover **40** is fitted to a pod body **10**, a washing liquid is introduced into the pod through the inlet **70** and is discharged from the pod through the outlet **80**, thereby cleaning the inside of the pod.

The pod of FIG. 3B has a pod body **10** and a cover **40** that are fixed together with bolts and nuts **62**. The cover **40** has an inlet **70** and an outlet **80**. A wafer cassette **130** with wafers is stored in the pod, the cover **40** is fitted to the pod body **10**, the bolts **62** are fastened to close the pod, a washing liquid is introduced into the pod through the inlet **70**, and the same is discharged from the pod through the outlet **80**, thereby simultaneously cleaning the inside of the pod, the wafers, and the wafer cassette.

The pod of FIG. 3C has an opening at the bottom of a pod body **12**. A cover **40** has an inlet **70** and an outlet **80**. The cover **40** is fitted to the pod body **12** to close the pod, a washing liquid or rinsing liquid is introduced into the pod through the inlet **70**, and the same is discharged from the pod through the outlet **80**, thereby cleaning the inside of the pod. At this time, a wafer cassette **130** with wafers may be kept in the pod so that the wafers and cassette are cleaned together with the inside of the pods.

The pod of FIGS. 4A and 4B is cylindrical, and a cover **40** is attached to the bottom of a pod body **12** by threads **160** and **165** formed thereon.

In FIG. 4A, the cover **40** has an inlet **70**, an outlet **80**, and holes **140** for turning the cover **40**. The threads of the pod body **12** and cover **40** are fastened together, a rotary tool **150** is inserted into the holes **140**, and the same is turned clockwise to tightly fix the cover **40** to the pod body **12**.

In this way, the pods of the embodiments 1-1 and 1-2 employ the covers **40** each having the inlet **70** and outlet **80** to easily wash and clean the insides of the pods.

The inlet **70** and outlet **80** are not limited to one each. There may be plural inlets and outlets formed on a pod cover. Fluid used to wash a pod through the inlet **70** and outlet **80** is not limited to liquid. It may be a washing gas. The fittings to fix a cover to a pod body are not limited to those explained above.

When storing and carrying substrates or wafers in the pods, the inlet and outlet of each cover **40** are closed with proper plugs to seal the insides of the pods.

[Embodiment 2]

FIGS. 5A to 5D show pods according to the embodiment 2 of the present invention. These pods are characterized by a pod body having an inlet and an outlet.

(Embodiment 2-1)

The pod of FIG. 5A consists of a pod body **10** and a cover **41**. The pod body **10** has an opening formed on a side face thereof to take in and out wafers. The cover **41** is attached to the opening of the pod body **10**. The pod body **10** has an inlet **71** and an outlet **81**.

The pod body **10** and cover **41** are fixed together to tightly close the pod. In FIG. 5A, the cover **41** is fitted to the pod body **10**. In FIG. 5B, the pod body **10** and cover **41** are fixed together with bolts and nuts.

After the pod body **10** and cover **41** are fixed together, the outlet **81** is closed, a washing liquid such as an acid or alkaline liquid is introduced into the pod through the inlet **71**, the liquid is kept for a predetermined time to etch off contaminants on the inner wall of the pod, the washing liquid is discharged from the pod through the outlet **81**, pure water is supplied into the pod through the inlet **71**, and the same is discharged from the pod through the outlet **81**, thereby rinsing and cleaning the inside of the pod.

This embodiment needs no separate washing tank to clean the inside of the pod because it uses the pod itself as a washing tank. As a result, this embodiment is economical and saves the space of a clean room. The pods of this embodiment may periodically be cleaned to properly maintain a clean atmosphere for wafers in the pods.

The pods of this embodiment may be cleaned with wafers being stored therein. In this case, not only the pods themselves but also the wafers are cleaned.

In FIGS. 5A and 5B, the pods have grooves **20** for directly supporting wafers. In FIGS. 5C and 5D, the pods have no such grooves, to store a wafer cassette that contains wafers.

7

(Embodiment 2-2)

FIG. 5E shows a pod according to an embodiment 2-2 of the present invention. The pod is cylindrical and has an opening at the bottom thereof to take in and out wafers. The pod consists of a pod body **10** and a cover **41**. The pod body **10** has an inlet **72** and an outlet **82** to easily wash the inside of the pod.

It is preferable that the inlet **71** (**72**) is formed as high as possible on the pod body **10**, and the outlet **81** (**82**) as low as possible. The pods of FIGS. 5A to 5D with an opening being formed on a side face thereof have each the inlet **71** on the top of the pod body **10** and the outlet **81** on the bottom of the pod body **10**.

The pod of FIG. 5E having the bottom opening has the inlet **72** on the top of the pod body **10** and the outlet **82** on the side wall of the pod body **10** adjacent to a fitting for fixing the cover **41** to the pod body **10**.

The fittings of the embodiment 1 or any other fittings for fixing a cover to a pod body are applicable to the embodiment 2.

[Embodiment 3]

FIGS. 6A to 6C show pods according to the embodiment 3 of the present invention. The embodiment 3 is characterized in that each cover has an inlet and an outlet and the inlet has a structure for jetting fluid.

(Embodiment 3-1)

FIG. 6A shows a pod according to an embodiment 3-1. The pod consists of a pod body **10** and a cover **42** that is tightly fitted to the pod body **10** to close the pod. The fittings of the embodiments 1 and 2 or any other fittings for fixing a cover to a pod body are applicable to the embodiment 3.

The cover **42** has an injection inlet **75** and an outlet **85**. The injection inlet **75** has thin holes arranged parabolically to jet liquid into the pod.

The cover **42** is removably fitted to the pod body **10** to tightly close the pod. A washing liquid is supplied into the pod through the injection inlet **75** and is discharged from the pod through the outlet **85**, thereby washing the inside of the pod without a special washing apparatus. The washing liquid of high pressure is showered into the pod through the injection inlet **75**, to strongly wash the inside of the pod.

(Embodiment 3-2)

FIG. 6B shows a pod according to an embodiment 3-2 of the present invention. The pod consists of a pod body **10** and a cover **42**. The cover **42** has an inlet **75** and an outlet **85**. The inlet **75** is provided with a nozzle **160**.

FIG. 6C is an enlarged view showing the nozzle **160** and the periphery thereof. The tip of the nozzle **160** is thinned to jet liquid of high pressure into the pod, thereby enhancing a washing effect.

The nozzle **160** may be fixed to the cover **42** in various ways. In FIG. 6C, the nozzle **160** is screwed into the cover **42** so that it may easily be replaced.

It is possible to use a conventional cover for the pod body **10** when storing and carrying the pod, and only when washing the pod, attach one of the covers **42** of the embodiments 3-1 and 3-2 to the pod body **10**.

Wafers can be left in the pods when the pods are washed so that not only the inner walls of the pods but also the wafers are washed.

In FIGS. 6A and 6B, the pod bodies **10** have grooves for directly supporting wafers. These grooves are not always

8

necessary for the pod bodies. The pod bodies and covers of the embodiment 3 are fixed together in various ways like the embodiments 1 and 2.

[Embodiment 4]

FIGS. 7A and 7B show pods according to the embodiment 4 of the present invention. This embodiment is characterized by a cover having a projection.

(Embodiment 4-1)

FIG. 7A is a sectional view showing a pod according to an embodiment 4-1. The pod consists of a pod body **10** and a cover **43**.

The cover **43** has a projection protruding into the pod body **10**. The size of the projection is not particularly limited. For example, the diameter of the projection is $\frac{1}{2}$ to $\frac{2}{3}$ of the inner diameter of the pod body **10**. The cover **43** has an inlet **73** and an outlet **83**.

The cover **43** is tightly fitted to the pod body **10**. A washing liquid is introduced into the pod through the inlet **73** and is discharged from the pod through the outlet **83**, thereby washing the inside of the pod by using the pod itself as a washing tank. At this time, the projection of the cover **43** reduces the inner volume of the pod, so that a small quantity of washing liquid can fill the inside of the pod. Namely, a small quantity of washing liquid will sufficiently wash the inside of the pod in a short time.

The pod body **10** has an opening for taking in and out wafers. The pod body **10** may have grooves for directly supporting wafers as shown in FIG. 7A.

(Embodiment 4-2)

FIG. 7B is a sectional view showing a pod according to an embodiment 4-2. The pod consists of a pod body **10** and a cover **43**.

The cover **43** has a projection protruding into the pod body **10**. An inlet **74** of the cover **43** is branched into thin holes in the cover **43**. The thin holes are equally distributed on the surface of the projection to jet liquid equally onto the inner wall of the pod, thereby realizing a high washing effect over the inner wall of the pod.

It is possible to use conventional covers for the pods of the embodiment 4 when storing and transferring the pods, and only when washing the pods, use the covers **42** of the embodiment 4.

[Embodiment 5]

FIGS. 8A to 8C show pods according to the embodiment 5. This embodiment is characterized by an agitating fin.

(Embodiment 5-1)

FIG. 8A is a sectional view showing a pod according to an embodiment 5-1. The pod consists of a pod body **10** and a cover **44**.

The cover **44** has an inlet **75** and an outlet **85**. In addition, the cover **44** has an agitating fin **180** and a motor **200** for driving the fin **180**. The cover **44** is tightly attached to the pod body **10**, a washing liquid is introduced into the pod through the inlet **75** to fill the pod with the washing liquid, and the motor **200** is started to rotate the fin **180**. The fin **180** agitates the washing liquid and generates swirls in the pod, thereby improving the washing power of the washing liquid.

FIG. 8C is a partial section showing the details of the motor **200** and fin **180** of the cover **44**. The motor **200** has

a magnet at a rotary end **210** thereof, and the fin **180** also has a magnet at a base **220** thereof. When the rotary end **210** turns, the fin **180** also turns due to magnetic repulsion.

(Embodiment 5-2)

FIG. **8B** is a sectional view showing a pod according to an embodiment 5-2 of the present invention. The pod consists of a pod body **10** and a cover **44**.

The cover **44** has an inlet **75**, an outlet **85**, a rotary brush **190**, and a motor **200** for driving the brush **190**.

The cover **44** is tightly attached to the pod body **10** to close the pod, a washing liquid is supplied into the pod through the inlet **75** to fill the pod with the washing liquid, and the motor **200** is started to rotate the brush **190**. The brush **190** generates swirls in the washing liquid and applies physical washing force on the inner wall of the pod.

The pod bodies **10** of the embodiment 5 have grooves on the inner walls thereof to directly support wafers. Any other pod bodies such as those of the embodiments 1 and 2 are applicable to the embodiment 5.

[Embodiment 6]

FIGS. **9A** to **10B** show pods according to the embodiment 6 of the present invention. This embodiment is characterized by a cover having an outlet.

Unlike the embodiments 1 to 5 that wash the inside of a pod, the embodiment 6 cleans and dries the inside of a pod.

(Embodiment 6-1)

FIG. **9A** is a sectional view showing a pod according to an embodiment 6-1 of the present invention. The pod consists of a pod body **10** and a cover **45**. The left part of FIG. **9A** shows the cover **45** being attached to the pod body **10**, and the right part thereof shows a vacuum pump **230** being operated.

The pod body **10** has an opening on a side face thereof to take in and out wafers. The cover **45** is attached to the opening. The cover **45** has an outlet **240**, which is connected to the vacuum pump **230**.

The cover **45** can be fitted to the pod body **10** according to any fitting technique. In FIG. **9A**, the cover **45** has a fixing frame **61** to fix the cover **45** to the pod body **10**.

Conventional pods used for semiconductor processing are rarely washed, and therefore, the inner walls thereof accumulate contaminants **250** after a long time of use as shown in the left part of FIG. **9A**. The contaminants are water, oxygen, etc., to contaminate wafers stored in the pods.

After a certain period of use of the pod, the cover **45** having the outlet **240** is attached to the pod body **10** to close the same, and the outlet **240** is connected to the vacuum pump **230** through a pipe. The pump **230** evacuates the pod so that the contaminants are discharged from the pod as shown in the right part of FIG. **9A**.

Although the pod of FIG. **9A** stores no wafers, wafers may be left in the pod when the cover **45** is attached to the pod body **10** to evacuate the pod.

A conventional cover having no outlet **240** can be attached to the pod body **10** when storing and transferring the pod, and only when the pod is cleaned, the conventional cover is replaced with the cover **45** having the outlet **240**.

(Embodiment 6-2)

FIG. **9B** is a sectional view showing a pod according to an embodiment 6-2. The pod consists of a pod body **10** and a cover **45**.

The cover **45** has an outlet **240** to be connected to a vacuum pump **230**, as well as a heater **260** for heating the inside of the pod.

In the left part of FIG. **9B**, the cover **45** is tightly fitted to the pod body **10**, and the heater **260** is turned on to heat the inside of the pod. Then, the vacuum pump **230** is started to easily volatilize contaminants adhering to the inner wall of the pod. In particular, water in the pod is easily volatilized by the heater **260** and is discharged from the pod. This embodiment effectively cleans the inside of the pod.

The temperature attained by the heater **260** is higher the better. The temperature, however, must be determined according to the heat resistance of the material of the pod. The pod may be made of metal. For example, the pod body **10** and cover **45** may be made of stainless steel and the seal thereof of copper. In this case, the temperature may be increased to several hundreds of degrees.

(Embodiment 6-3)

FIGS. **10A** and **10B** are sectional views showing pods each consisting of a pod body **10** and a cover **45**. The left part of each figure shows the cover **45** being fitted to the pod body **10**, and the right part thereof shows a vacuum pump **230** being operated.

Each pod has an opening at the bottom thereof, and the cover **45** is screwed into the pod body **10**.

Irrespective of whether the opening of the pod body **10** is on the bottom or side face thereof, the cover **45** having an outlet **240** is fitted to the pod body **10**, and the vacuum pump **230** is connected to the outlet **240**. The vacuum pump **230** is driven to evacuate the pod, to thereby discharge contaminants adhering to the inner wall of the pod to the outside of the pod.

In FIG. **10B**, the cover **45** has a heater **260** in addition to the outlet **240**. The heater **260** heats the inside of the pod to volatilize contaminants in the pod, to more effectively discharge the contaminants out of the pod.

[Embodiment 7]

The embodiment 7 of the present invention will be explained with reference to FIG. **11A**.

The embodiment 7 relates to a post-process to be carried out after a pod is washed according to any one of the embodiments 1 to 5 or any other techniques. The post-process is carried out with the use of the cover **45** of the embodiment 6.

In FIG. **11A**, a pod is washed according to a conventional washing process. A washing tank **270** is filled with a washing liquid **280**. A pod body **10** of the pod is dipped in the washing liquid **280** so that contaminants on the inner wall of the pod body **10** are etched off. Thereafter, the pod body **10** is washed with pure water. After that, remnants on the inner wall of the pod body **10** must be removed and the pod body **10** must be dried.

In FIG. **11B**, the cover **45** having the outlet **240** connected to the vacuum pump **230** is tightly fitted to the pod body **10**, to evacuate the pod body **10**. This technique needs no large dryer, to effectively remove remnants from the pod body **10**.

In FIG. **11C**, the cover **45** having the heater **260** is used to dry the pod body **10**. The heater **260** quickly dries the inside of the pod body **10** and removes remnants **250** from the pod body **10**.

The inside of a pod can be washed not only by dipping the pod in a tank filled with a washing liquid but also by any one

11

of the embodiments 1 to 5 that employ the covers having an inlet and an outlet. If any one of the embodiments 1 to 5 is employed, a series of washing processes can be completed only by changing the cover of a given pod.

Fixing a cover to a pod body can be achieved according to any technique as mentioned above.

[Embodiment 8]

The embodiment 8 of the present invention will be explained with reference to FIGS. 12A to 14B. This embodiment employs a cleaning apparatus to carry out a post-process on a washed pod.

(Embodiment 8-1)

FIG. 12A is a sectional view showing a cleaning apparatus employing a pod body 10 and a cover 46 according to an embodiment 8-1 of the present invention.

The cover 46 has an inlet 75 and an outlet 85. The inlet 75 is connected to a pipe, which is connected to a gas supply source (not shown). In the middle of the pipe, a valve 320 for adjusting a gas supply rate is arranged.

The outlet 85 is connected to a pipe in which a vacuum pump 230 is arranged to evacuate the pod.

The cover 46 is provided with a pressure sensor 310 to monitor a pressure in the pod. The pressure sensor 310, valve 320, and pump 230 are electrically connected to a controller 300, which controls a gas supply rate and gas discharge rate according to the pressure in the pod.

The post-process to be carried out on a washed pod will be explained. The pod is washed according to a conventional technique or any one of the embodiments 1 to 5. The cover 46 is tightly attached to the pod body 10. The valve 320 is closed, and the pump 230 is started to evacuate the pod and remove remnants from the pod. When the pressure sensor 310 indicates a pressure level below a set level, for example, 100 Pa, the pump 230 is stopped, or a valve (not shown) is used to stop the discharging of the pod.

The valve 320 is opened to gradually introduce a high purity inert gas of, for example, nitrogen (N₂) or argon (Ar). When the pressure sensor 310 indicates an atmospheric pressure, the valve 320 is closed, or the cover 46 is removed from the pod body 10, to complete the post-process. At this time, remnant gases in the pod have been replaced with the high purity inert gas.

Although the arrangement of FIG. 12A shows no tool for fixing the cover 46 to the pod body 10, they will naturally be joined together when the pod is evacuated, or any fitting of the preceding embodiments will be employed.

The embodiment of FIG. 12B provides the cover 46 of FIG. 12A with a heater 340. The cover 46 is attached to the pod 10, and the heater 340 is turned on before evacuating the pod with the pump 230 or during the evacuation of the pod. Heating the inside of the washed pod easily gasifies remnants in the pod. Thereafter, the pod is filled with an inert gas as mentioned above, to thereby effectively remove the remnants from the pod.

FIG. 13 shows the details of the cover 46 of FIG. 12A and piping connected thereto. An automatic pressure controller (APC) 231 may be connected to the pipe that is connected to the outlet of the cover 46. The APC 231 is in front of the pump 230. The APC 231 is electrically connected to the controller 300, to automatically adjust a discharge rate in response to the output of the pressure sensor 310.

A valve 321, a pressure gauge 322, a filter 323, a mass flow controller (MFC) 324, etc., may be connected to the

12

pipe that extends between the inlet of the cover 46 and the inert gas supply source 325. The MFC 324 is electrically connected to the controller 300, to automatically adjust a gas supply rate in response to the output of the pressure sensor 310.

In FIGS. 11A to 12B, each pod body 10 has grooves on the inner wall thereof, to directly support wafers, and jointing between the pod body 10 and the cover 46 is by fitting them together. These structures do not limit the present invention. For example, pod bodies having no grooves for supporting wafers may be used as shown in FIGS. 14A and 14B. Jointing between the pod bodies 10 and the covers 46 may be of a screw type as shown in FIGS. 14A and 14B, or of any other type.

[Embodiment 9]

The embodiment 9 of the present invention will be explained with reference to FIGS. 15 to 24. This embodiment relates to semiconductor processing apparatuses having a pod cleaning function.

(Embodiment 9-1)

FIG. 15A shows a semiconductor processing apparatus according to an embodiment 9-1 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber 400, a pod processing chamber 410, and a wafer processing chamber 420. The wafer processing chamber 420 involves wafer processing units for forming or etching thin films on wafers.

The apparatus handles, as an example, a cylindrical pod having an opening at the bottom thereof to take in and out wafers. Wafers are stored in a conventional open-type wafer cassette 130, which is stored in the pod. The pod consists of a pod body 10 and a cover 47. The cover 47 may be of the embodiment 1 having an inlet 70 and an outlet 80.

Generally, wafers are transferred in pods between semiconductor processing apparatuses. The pod reception chamber 400 of the semiconductor processing apparatus receives a given pod. Although the pod of FIG. 15A is carried by a person, it may be carried by machine such as a transportation robot.

In FIG. 15A, the pod with wafers is set in the pod reception chamber 400. The wafers set in the wafer cassette 130 are taken out of the pod and transferred to the wafer processing chamber 420. The vacant pod is left in the pod processing chamber 410.

FIGS. 16A to 16C show the wafer transferring process. In FIG. 16A, the pod is in the pod reception chamber 400. In FIG. 16B, the cover 47 is removed from the bottom of the pod. The pod body 10 is left there. The cover 47 and the wafer cassette 130 thereon are put on a vertically movable table, which carries them downwardly. The pod processing chamber 410 has an arm 430. The arm 430 carries the wafer cassette 130 with the wafers therein from the pod reception chamber 400 to the wafer processing chamber 420 through the pod processing chamber 410. The wafers in the chamber 420 are processed in various ways.

In FIG. 16C, the cover 47 is returned to a predetermined position in the pod reception chamber 400 where the pod body 10 is left and is attached to the opening of the pod body 10. The pod body 10 with the cover 47 is moved to the pod processing chamber 410 and is set at a predetermined position by the arm 430.

The inlet and outlet of the cover 47 are connected to pipes arranged in the pod processing chamber 410. The pipes have

13

valves **350** and **360**. The valve **360** is opened to introduce a washing liquid into the pod and is closed to fill the pod with the washing liquid, thereby washing the inside of the pod.

In this way, the semiconductor processing apparatus of this embodiment has the pod processing chamber **410** separately from the wafer processing chamber **420**, to clean a pod while processing wafers in the chamber **420**. The pod processing chamber **410** is provided with the pipes to be connected to the inlet **70** and outlet **80** of the cover **47**, so that the pod itself serves as a washing tank to wash the inside thereof. This helps reduce the size of the pod processing chamber **410**. Since the pod processing chamber **410** is adjacent to the wafer processing chamber **420**, there is no need of transferring the pod to a cleaning apparatus at a distant location, thereby improving the efficiency of the pod cleaning process.

(Embodiment 9-2)

FIG. **15B** shows a semiconductor processing apparatus according to an embodiment 9-2 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **47**. The pod body **10** has a bottom opening, and the cover **47** has an inlet **70**, a first outlet **80**, and a second outlet **370**.

Wafers are held in a wafer cassette **130**, which is stored in the pod. After the cassette **130** with the wafers is transferred from the pod to the wafer processing chamber **420**, the pod body **10** and cover **47** are moved to a predetermined position in the pod processing chamber **410**. The inlet **70** and outlet **80** of the cover **47** are connected to pipes having valves **350** and **360**. The outlet **370** is connected to a pipe that is connected to a vacuum pump **230**.

The pod is filled with a washing liquid to clean the inside thereof. Thereafter, the pod is evacuated by the pump **230** through the outlet **370**, to remove remnants from the pod.

Mechanisms for transferring the pod and wafers of the apparatus of FIG. **15B** are the same as those of FIG. **16A** to **16C**.

(Embodiment 9-3)

FIG. **17A** shows a semiconductor processing apparatus according to an embodiment 9-3 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **47**. The pod body **10** has an open bottom, and the cover **47** has an inlet **70** and an outlet **80**. The embodiment 9-3 is characterized by a heater **450** arranged in the pod processing apparatus **410**, to surround the pod.

The heater **450** heats the pod and a washing liquid in the pod, to improve the washing power of the washing liquid. The heater **450** may heat pure water to rinse the pod. Heated waterdrops in the pod speedily dry to shorten a drying time. The heater **450** may be used to dry remnants in a washed pod.

(Embodiment 9-4)

FIG. **17B** shows a semiconductor processing apparatus according to an embodiment 9-4 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by

14

the apparatus consists of a pod body **10** and a cover **47**. The pod body **10** has an open bottom, and the cover **47** has an inlet **70** and an outlet **80**. The embodiment 9-4 is characterized by a valve **350** and a heater **460** both arranged in the middle of a pipe connected to the inlet **70**.

The heater **460** surrounds a part of the pipe to heat a washing liquid passing through the pipe, thereby improving the washing power of the washing liquid. The heater **460** may heat a rinsing liquid such as pure water to rinse the inside of the pod. Waterdrops in the pod dry speedily to shorten a drying time.

(Embodiment 9-5)

FIG. **18A** shows a semiconductor processing apparatus according to an embodiment 9-5 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the opening of the pod body **10** is directly set on a table. To tightly close the opening of the pod body **10**, the table has a fitting part.

In FIG. **18A**, the fitting part has the same shape as the opening of the pod body **10**. The table has an inlet **470** and an outlet **480**.

The inlet **470** and outlet **480** are connected to pipes to introduce fluid into the pod and discharge the same from the pod. The pipes have valves **350** and **360** to adjust the supply and discharge rates of the fluid. The embodiment 9-5 washes the inside of the pod in the same manner as the embodiment 9-1.

In this way, the table arranged in the pod processing chamber **410** has the fitting part for closing the pod body **10** on the table, the inlet **470** for introducing a washing liquid into the pod, and the outlet **480** for discharging the washing liquid from the pod. This arrangement efficiently uses the time for processing wafers, to wash the inside of the pod. Since the pod processing chamber **410** is adjacent to the wafer processing chamber **420**, no labor is needed to transfer the pod between them, thereby improving workability.

The embodiment 9-5 transfers the pod and wafers as shown in FIGS. **19A** and **19B**.

In FIG. **19A**, the pod processing chamber **410** has an arm **430** for carrying a pod or a wafer cassette.

In FIG. **19B**, a pod with wafers is at a predetermined position in the pod reception chamber **400**. A cover and a wafer cassette **130** on the cover are removed from a pod body **10** and are put on a table that is vertically movable. The table is moved downwardly for a predetermined distance. The arm **430** carries the wafer cassette **130** with the wafers from the pod reception chamber **400** to the wafer processing chamber **420** through the pod processing chamber **410**.

The pod body **10** is transferred from the pod reception chamber **400** to the pod processing chamber **410** by, for example, a belt conveyor arranged in the pod reception chamber **400**. The arm **430** sets the pod body **10** to a predetermined position on the table in the pod processing chamber **410**.

(Embodiment 9-6)

FIG. **18B** shows a semiconductor processing apparatus according to an embodiment 9-6 of the present invention and a series of processes carried out thereby. The apparatus has

15

a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

The pod body **10** is directly set on a table in the pod processing chamber **410**. The table is shaped to tightly close the bottom opening of the pod body **10**.

The table has an inlet **470**, a first outlet **480**, and a second outlet **490**. The outlet **490** is connected to a vacuum pump **230** to evacuate the pod.

The inlet **470** and outlet **480** are used to wash the inside of the pod, and the outlet **490** and pump **230** are used to evacuate the washed inside of the pod, thereby removing remnants from the pod in a short time.

The mechanisms for transferring the pod and wafers are the same as those of FIGS. **19A** and **19B**.

(Embodiment 9-7)

FIG. **20A** shows a semiconductor processing apparatus according to an embodiment 9-7 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the pod body **10** is directly set on a table. The table has a fitting part for tightly closing the pod body **10**. The table has an inlet **470** and an outlet **480**.

The pod processing chamber **410** has a heater **450** to surround the pod body **10**. The inlet **470** and outlet **480** are used to wash the inside of the pod body **10**. At this time, the heater **450** is turned on to heat a washing liquid and improve the washing power thereof. After the washing of the pod body **10**, the heater **450** may be turned on to heat the pod body **10** and dry remnants in the pod body **10** in a short time.

(Embodiment 9-8)

FIG. **20B** shows a semiconductor processing apparatus according to an embodiment 9-8 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the pod body **10** is directly set on a table. The table has a fitting part for tightly closing the pod body **10**, an inlet **470**, an outlet **480**, and a heater **451** to be entirely received in the pod body **10**.

The inlet **470** and outlet **480** are used to wash the inside of the pod body **10**. At this time, the heater **451** is turned on to heat a washing liquid and improve the washing power thereof. The heater **451** may be turned on after the washing of the pod body **10**, to dry remnants in the pod body in a short time.

(Embodiment 9-9)

FIG. **21A** shows a semiconductor processing apparatus according to an embodiment 9-9 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber

16

410, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the pod body **10** is directly set on a table. The table has a fitting part for tightly closing the opening of the pod body **10**. The table has an inlet **470** and an outlet **480**, which are connected to pipes. A part of the pipe that is connected to the inlet **470** is covered with a heater **460**.

The inlet **470** and outlet **480** are used to wash the inside of the pod body **10**. At this time, the heater **460** heats a washing liquid to improve the washing power thereof and shorten a drying time of the washing liquid in the pod body **10**.

(Embodiment 9-10)

FIG. **21B** shows a semiconductor processing apparatus according to an embodiment 9-10 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the pod body **10** is directly set on a table. The table has an inlet **470**, an outlet **480**, and a fitting part for tightly closing the opening of the pod body **10**. An end of the inlet **470** is provided with a nozzle **500**.

The nozzle **500** jets liquid into the pod body **10**, to realize high washing power. The tip of the nozzle **500** may be narrowed as shown in FIG. **6C**.

(Embodiment 9-11)

FIG. **22A** shows a semiconductor processing apparatus according to an embodiment 9-11 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the pod body **10** is directly set on a table. The table has a projection **510** entering into the pod body **10**. The table has an inlet **471** and an outlet **481** at the periphery of the projection **510**.

The projection **510** reduces the inner volume of the pod body **10**, so that the inside of the pod body **10** can efficiently be washed with a small quantity of washing liquid.

(Embodiment 9-12)

FIG. **22B** shows a semiconductor processing apparatus according to an embodiment 9-12 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber **400**, a pod processing chamber **410**, and a wafer processing chamber **420**. A pod handled by the apparatus consists of a pod body **10** and a cover **48**. The pod body **10** has an open bottom, and the cover **48** is a conventional one having no inlet or outlet.

In the pod processing chamber **410**, the pod body **10** is directly set on a table, which is provided with an agitating fin **530**.

The fin **530** agitates a washing liquid filled in the pod body **10**, to improve the washing power thereof.

17

(Embodiment 9-13)

FIG. 23 shows a semiconductor processing apparatus according to an embodiment 9-13 of the present invention and a series of processes carried out thereby. The apparatus has a pod reception chamber 400, a pod processing chamber 410, and a wafer processing chamber 420. A pod handled by the apparatus consists of a pod body 10 and a cover 48. The pod body 10 has an open bottom, and the cover 48 is a conventional one having no inlet or outlet.

In the pod processing chamber 410, the pod body 10 is directly set on a table, which is provided with a rotary brush 540.

When the inside of the pod is washed, the brush 540 is used to improve washing power.

(Embodiment 9-14)

FIG. 24A shows a semiconductor processing apparatus according to an embodiment 9-14 of the present invention and a series of processes carried out thereby. This embodiment is based on the embodiment 9-1 of FIG. 15A. Namely, the apparatus has a pod reception chamber 400, a pod processing chamber 410, and a wafer processing chamber 420. A pod handled by the apparatus consists of a pod body 10 and a cover 47 having an inlet 70 and an outlet 80. In the pod processing chamber 410, the pod body 10 and the cover 47 are tightly fitted together to close the pod.

The inlet 70 and outlet 80 are connected to pipes through which a washing liquid is introduced into the pod and discharged therefrom, thereby washing the inside of the pod. At this time, wafers are left in the pod.

The pod and wafers are simultaneously washed in the pod processing chamber 410, and then, the wafers are taken out of the pod and are transferred to the wafer processing chamber 420. Namely, the chamber 420 can process the wafers that have been washed and clean.

The other embodiments mentioned above may also simultaneously wash a pod and wafers stored therein if a space left in the pod is sufficient to hold the wafers. Simultaneously washing a pod and wafers and transferring the washed wafers to the wafer processing chamber 420 improves the yield of semiconductor products to be produced from the wafers.

The wafer processing chamber 420 forms thin films such as silicon oxide films and silicon films on the wafers and patterns the thin films by, for example, photolithography. In this case, the cleanliness of the surface of each wafer greatly influences the characteristics and yield of the thin films to be formed and processed. Accordingly, washing wafers just before processing them is effective to form quality thin films thereon.

If the wafer processing chamber 420 etches a film on the wafers, the pod and wafers may simultaneously be washed as mentioned above after the completion of the etching process.

(Embodiment 9-15)

FIG. 24B shows a semiconductor processing apparatus according to an embodiment 9-15 of the present invention and a series of processes carried out thereby. This embodiment is based on the embodiment 9-5 of FIG. 18A. Namely, the apparatus has a pod reception chamber 400, a pod processing chamber 410, and a wafer processing chamber 420. A pod handled by the apparatus consists of a pod body 10 and a cover 48. The pod body 10 has an open bottom, and

18

the cover 48 is a conventional one having no inlet or outlet. The pod processing chamber 410 has a table on which the pod body 10 is directly set. At this time, the pod body 10 is holding wafers, and the pod body 10 and wafers are simultaneously washed.

In the pod processing chamber 410, the pod body 10 is tightly fixed to the table. A washing liquid is introduced into and discharged from the pod body 10 through an inlet 471 and an outlet 481 formed on the table, thereby washing the inside of the pod body 10. At this time, the wafers in the pod body 10 are also washed.

The washed wafers are taken out of the pod body 10 and are transferred to the wafer processing chamber 420. Processing the clean wafers improves the yield of semiconductor products to be produced from the wafers. The embodiment is particularly effective when forming thin films such as silicon oxide films and silicon films on the wafers because the cleanliness of the surface of each wafer greatly influences the yield of the thin films.

Although the embodiments 9-1 to 9-15 handle pods having a bottom opening, they can also handle pods having a side opening by changing the mechanisms for transferring a pod. The structure for attaching a pod body to the table in the pod processing chamber 410 may have any design.

The wafer processing chamber 420 may contain various semiconductor processing units including plasma CVD apparatuses, sputtering apparatuses, and thermal CVD apparatuses for forming insulation films, semiconductor films, and conductive films, as well as ion injection apparatuses, thermal diffusion apparatuses, and dry etching apparatuses.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof.

Wafers and substrates stored in the pods may be silicon wafers, sapphire substrates, GaAs substrates, glass substrates, etc.

What is claimed is:

1. An apparatus for processing substrates stored in a pod including a pod body having an opening for taking in and out the substrates and a cover for closing the opening of the pod body, comprising:

- a pod reception chamber;
- a pod processing chamber;
- a substrate processing chamber;
- means for transferring the pod and substrates between the chambers;
- substrate taking means in the pod reception chamber, for taking the substrates out of the pod;
- cleaning means in the pod processing chamber, for cleaning the inside of the pod; and
- substrate processing means in the substrate processing chamber for forming or etching films such as semiconductor films, insulation films, and conductive films on the substrates.

2. An apparatus for processing substrates stored in a pod including a pod body having an opening for taking in and out the substrate and a cover for closing the opening of the pod body, comprising:

- a pod reception chamber;
- a pod processing chamber;
- a substrate processing chamber;
- means for transferring the pod and substrates between the chambers;
- substrate taking means in the pod reception chamber, for taking the substrates out of the pod;

cleaning means in the pod processing chamber, for cleaning the inside of the pod; and
 substrate processing means in the substrate processing chamber, for processing the substrate, wherein
 the cover has an outlet; and
 the cleaning means has closing means for tightly closing the opening of the pod body with the cover, introducing means for introducing a washing liquid into the pod through the inlet, and discharging means for discharging the washing liquid from the pod through the outlet.
3. The apparatus of claim 2, wherein:
 the cleaning means has heating means for heating the inside of the pod.
4. The apparatus of claim 2, wherein:
 the cleaning means has heating means for heating the washing liquid to be introduced into the pod.
5. An apparatus for processing substrates stored in a pod including a pod body having an opening for taking in and out the substrate and a cover for closing the opening of the pod body, comprising:
 a pod reception chamber;
 a pod processing chamber;
 a substrate processing chamber;
 means for transferring the pod and substrates between the chambers;
 substrate taking means in the pod reception chamber, for taking the substrates out of the pod;
 cleaning means in the pod processing chamber, for cleaning the inside of the pod; and
 substrate processing means in the substrate processing chamber, for processing the substrate, wherein
 the cover has an outlet; and
 the cleaning means has evacuating means for evacuating the pod through the outlet.
6. An apparatus for processing substrates stored in a pod including a pod body having an opening for taking in and out the substrate and a cover for closing the opening of the pod body, comprising:
 a pod reception chamber;
 a pod processing chamber;
 a substrate processing chamber;

means for transferring the pod and substrates between the chambers;
 substrate taking means in the pod reception chamber, for taking the substrates out of the pod;
 cleaning means in the pod processing chamber, for cleaning the inside of the pod; and
 substrate processing means in the substrate processing chamber, for processing the substrate, wherein
 the cleaning means has:
 a table on which the pod body is set to tightly close the inside of the pod body;
 an inlet and an outlet formed on the table, the inlet introducing fluid into the pod body, the outlet discharging fluid from the pod body;
 introducing means for introducing a washing liquid into the pod body through inlet; and
 discharging means for discharging the washing liquid from the pod body through the outlet.
7. The apparatus of claim 6, wherein the table has:
 a second outlet; and
 evacuating means for evacuating the pod body through the second outlet.
8. The apparatus of claim 6, wherein:
 the cleaning means is provided with heating means for heating the pod body.
9. The apparatus of claim 6, wherein:
 the cleaning means is provided with heating means for heating the washing liquid to be introduced into the pod body through the inlet.
10. The apparatus of claim 6, wherein:
 the inlet has at least one nozzle for jetting the washing liquid into the pod body.
11. The apparatus of claim 6, wherein:
 the table has a projection protruding into the pod body.
12. The apparatus of claim 6, wherein the table has:
 at least one of a fin for agitating fluid in the pod body and a brush for washing the inside of the pod body; and
 driving means for driving the fin and brush.

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